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DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY
GEORGE OTIS SMITH, DIRECTOR

MINERAL RESOURCES
OF THE
UNITED STATES

CALENDAR YEAR
1911

PART II—NONMETALS

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MINERAL RESOURCES OF THE UNITED STATES FOR 1911—PART II.

COAL.

By Edward W. Parker.

INTRODUCTION.

GENERAL STATEMENT.

The series of reports on the production of coal in the United States prepared by the writer attains its majority in the present chapter, the report for 1911 being the twenty-first since the writer took charge of the work. In 1890, twenty-one years earlier than the output herein considered, the production of coal in the United States amounted to a little less than 160,000,000 short tons, at that time deemed a large tonnage and the maximum output up to that year, but less than one-third of the present output. In 1890 the United States was the second coal-producing country of the world, Great Britain's production exceeding that of this country by about 30 per cent. Within a decade, however, the United States had overtaken Great Britain and has maintained the advantage with an increasing lead each year until at the present time the production of coal in the United States exceeds that of Great Britain by 60 per cent. When the first report on the mineral resources of the United States was published by the United States Geological Survey, covering the calendar year 1882, our coal production was a little over 100,000,000 short tons, about one-fifth that now being mined. This was exceeded in 1911 by Pennsylvania alone by 40 per cent.

The principal feature of the coal-mining industry in 1911 was the decrease in the manufacture of coke, due to the depressed state of the iron industry and the consequent slack demand from the furnaces. The decreased production in 1911 was in the States where coke making is an important factor, and in those which profited by the strike in the Mississippi Valley States in 1910. There were no serious interruptions due to strikes in 1911, and the five States which suffered most from the strike of the previous year, Illinois, Missouri, Kansas, Oklahoma, and Arkansas, all showed substantial increases in 1911. Car supply was generally satisfactory in 1911, but some complaint was made of shortage of labor in certain districts.

The report for 1910 contained sectional maps of the coal fields of the United States with brief descriptions prepared by geologists of the Survey. Copies of that report are still available and can be secured free of charge upon application to the Director of the United States Geological Survey. A special feature of the present chapter is a statement of the extent to which shooting off the solid is practiced in the bituminous coal mines of the several States, from which some instructive conclusions may be drawn. The more frequently that practice is condemned by writers and speakers and the more widely it is prohibited by law and by company rules, the better it will be for the industry and for the safety of the miners.

ACKNOWLEDGMENTS.

The statistics of coal production, as of other branches of the mining industry, are compiled from direct returns by the operators. They could not be secured in the completeness in which they are presented without the hearty good will and cooperation of the corporations, firms, and individuals engaged in the industry, and the author desires to reiterate and emphasize his appreciation of the assistance received from these sources. Acknowledgments are also due to the State geological surveys of Alabama, Georgia, Illinois, Iowa, Kansas, Kentucky, Maryland, Michigan, Oregon, Pennsylvania, Virginia, and Washington for efficient cooperation in the collection of coal-mining statistics in those States, and to the secretaries of boards of trade or other local authorities for contributions on the coal trade of some of the principal cities. Recognition of these contributions is also given in connection with their contributions under the caption "Coal trade review." Not the least of the writer's acknowledgments are due to his faithful and efficient clerical and stenographic assistants in the United States Geological Survey.

UNIT OF MEASUREMENT.

The standard unit of measurement adopted for this report is the short ton of 2,000 pounds, although it is necessary in a few instances to use the long ton. All of the anthracite product is mined and sold on the basis of the long ton of 2,240 pounds. Hence, when the production of Pennsylvania anthracite is considered, the long ton is used. The long ton is also used in the statistics of imports and exports. In all other cases where the production is reported in long tons the figures have been reduced to short tons, and unless otherwise expressly stated the short ton is meant where any statement of quantity is made in the text.

SUMMARY OF STATISTICS IN 1911.

Total production in 1911, 496,221,168 short tons; spot value, $626,366,876.

Pennsylvania anthracite.—Total production in 1911, 80,771,488 long tons (equivalent to 90,464,067 short tons); spot value, $175,189,392.

Bituminous coal and lignite.—Total production in 1911, 405,757,101 short tons; spot value, $451,177,484.

Increase and decrease.—The statistics covering the production of coal in the United States in 1911 show a decrease from 501,596,378 short tons, valued at $629,557,021, in 1910, to 496,221,168 short tons, valued at $626,366,876. The decline in 1911 was 5,375,210 short tons, or a little over 1 per cent in quantity, and $3,190,145, or 0.51 per cent in value. The decrease may be attributed entirely to the depressed condition of the iron and steel trade in 1911, which was reflected in the decreased production of coke. The three leading coke-producing States, Pennsylvania, Alabama, and West Virginia, showed an aggregate decrease in coal production of 8,696,843 short tons, more than 1½ times the total decrease, and the decrease in the total quantity of coal made into coke was 9,970,283 short tons, or from 52,187,450 tons in 1910 to 42,217,167 tons in 1911. Four States, Indiana, Ohio, Kentucky, and Iowa, which profited most in increased production from the strike among the miners of the Mississippi Valley States in 1910, showed a combined decrease of 9,151,094 tons in 1911. All of the States in which production in 1910 was curtailed by the strike of that year, except Michigan, showed good gains in 1911. Illinois particularly made a notable recovery with an increase of 7,778,872 tons in 1911, this gain being over 2,750,000 tons more than the decrease in 1910. Kansas showed the largest percentage of increase (1,332,777 tons, or 27.08 per cent), and was followed closely by Missouri with 778,174 tons, or 26.09 per cent.

The total decrease in the production of bituminous coal was 11,354,041 short tons, or 2.72 per cent in quantity, and $18,104,235, or 3.9 per cent, in value. More than half of this decrease was made up by the increase in the production of anthracite in Pennsylvania, which showed a gain of 5,338,242 long tons (5,978,831 short tons), or 7.08 per cent, in quantity and of $14,914,090, or 9.31 per cent, in value. Considering the marked decrease in the production and consumption of coke and that large quantities of coal outside of that used for coke making are consumed in the iron trade, the comparatively small net decrease (5,375,210 short tons) in coal production must be taken as an indication that other manufacturing industries, the transportation companies, and the country generally were prosperous. The average price for bituminous coal was only 1 cent less in 1911 than in 1910 ($1.11 against $1.12), and that of anthracite was 3 cents higher ($1.93 against $1.90) per short ton.

Coal was produced in 30 States and the Territory of Alaska in 1911, but in 4, namely, Idaho, Nevada, Alaska, and North Carolina, the aggregate output was less than 3,000 tons; in one other, California, the production was only a little more than 10,000 tons, and in Oregon it was less than 50,000 tons. Of the 27 States in which coal production may be considered to be on a commercial basis, there were 10 in which the output in 1911 was larger than in 1910, and 17 in which it declined. Of the 10 States in which the production increased, only 2, Pennsylvania and Virginia, are Eastern States. Six were Central States, or in the interior province, and 2 were Rocky Mountain States. Of the 17 States in which coal production decreased, 6 were in the Appalachian region; 1, Kentucky, draws its coal from both the Appalachian and the Interior regions; 3 belong entirely to the Interior region; 4 were in the Rocky Mountain region, and 3 belong to the Pacific coast province. As already stated, the principal decreases were in the chief coke-producing States and in those States which profited by the strike of 1910. The largest losses were sustained by the coke-producing States, Pennsylvania (5,767,363 short tons of bituminous coal), West Virginia (1,839,439 short tons), Colorado (1,816,353 tons), Alabama (1,090,041 tons), and New Mexico (360,163 tons). Indiana's production, which in 1910 was increased nearly 25 per cent by the shortage of coal in the Illinois markets, declined 4,188,460 short tons in 1911; Ohio's decreased 3,449,682 tons; Kentucky's, 916,480 tons, and Iowa's, 596,472 tons. The production of Maryland, in the east, and of Wyoming, in the west, had also been somewhat stimulated by the strike in the Mississippi Valley States, and both showed decreased production in 1911, Maryland by 531,330 tons and Wyoming by 788,224 tons. Virginia was the only State which is at the same time a producer of coke, which was benefited by the strike of 1910, and which showed an increased production in 1911. All of the Pacific coast States, California, Oregon, and Washington, showed decreased production in 1911, although neither the production nor the decreases in California and in Oregon were of essential importance. Washington is the only important coal-producing State on the Pacific coast. Its production declined 339,084 tons in 1911. All of the decreased production of coal on the Pacific coast was due to the increased competition of fuel oil, the details of which are discussed in the section devoted to the review of the coal trade and in the discussion of the production by States. There were 3 States where the value of the coal averaged less than $1 per ton in 1911. The most striking instance is that of West Virginia, where, although the product is of the highest grade of bituminous and semibituminous coal produced in the United States, the average price in 1911 was 90 cents per short ton. In Virginia, where similar conditions prevail, the average price was 91 cents. In Kentucky the average price was 99 cents. The highest average price was for the rather low-grade lignite of Oregon, $2.32, and in Washington the average price was $2.29. The mean average price of bituminous coal in 1911 was $1.11, compared with $1.12 in 1910. The average price for anthracite advanced from $1.90 in 1910 to $1.94 in 1911. This advance in anthracite was due chiefly to the smaller percentage of washery coal sold in 1911 and to the advance of 25 cents a ton on pea coal, that advance having been made in order to equalize the demand. It is somewhat difficult to draw conclusions from the slight variations in average prices of coal from one year to another. It frequently happens that in times of depression prices will reach a higher level than when more prosperous conditions prevail. This is due to the fact that when business is poor, producers of coal are more exacting in their requirements, and that in years of active demand the operators are able to dispose of inferior grades. This indicates an apparent decrease in the average price when it may have actually meant a better return to the producer. In 1911 on account of the small demand for coke, considerably more slack coal was placed on the market, and a part of the decline in price is due to the lower value of that grade of fuel when marketed as compared with the value placed upon it when charged into the coke ovens. It should also be remembered that the small sizes of anthracite which are sold for raising steam, whether from culm banks or from freshly mined coal, are sold for less than the actual cost of producing run-of-mine coal. The same is true of the bituminous slack produced in the noncoking-coal fields.

Growth by decades.—An interesting and almost startling fact in connection with the production of coal in the United States is that in each successive decade the output is practically doubled. If the production of bituminous coal alone were considered, the record for the last 50 years would show an increase somewhat in excess of this ratio. The increase in the production of anthracite has been much less rapid on account of the limited area of the fields and of the conditions under which the industry is carried on and to the restriction of the prepared sizes to domestic consumption. It is doubtful, therefore, if the production of anthracite will much exceed that of the present time. It has been estimated that the output of anthracite will reach 100,000,000 long tons annually before it begins to decline. The maximum production up to the present time was 80,771,488 long tons. An increase in the annual production of bituminous coal may be anticipated for some time to come.

The statistics of coal production in the past show that up to the close of 1865 the total output had amounted to 284,890,055 short tons. In the decade from 1866 to 1875, inclusive, the production amounted to 419,425,104 tons, making the total production up to the close of 1875, 704,315,159 tons. In the following decade, from 1876 to 1885, inclusive, the output amounted to 847,760,319 tons, somewhat more than double the total production during the preceding decade. At the close of 1885 the total production amounted to 1,552,075,478 tons, and the production during the 10 years ended in 1895 was 1,586,098,641 tons, the total production at the close of 1895 amounting to 3,138,174,119 short tons. In the decade ended December 31, 1905, the total production amounted to 2,832,402,746 short tons, and the grand total from the beginning of recorded coal mining in the United States amounted to 5,970,576,865 short tons. The average annual production from 1896 to 1905 was 283,240,275 short tons, compared with which the average production from 1906 to 1911, inclusive, was 461,499,260 short tons, showing an increase of 178,258,985 short tons, or 63 per cent.

Growth and population.—It has been customary in the recent reports of this series to present comparisons of the growth of coal production with the growth of population. These comparisons indicate that the United States has changed from an agricultural to a manufacturing country. During the last 60 years, or from 1850 to the close of 1910, the per capita consumption of coal has increased from a little over one-fourth of a ton to nearly 5½ tons. In 1850, according to the United States census, the production of coal in the United States amounted to 6,445,681 short tons, and the population amounted to 23,191,876. The per capita production of coal in that year is thus seen to have been 0.278 ton. Ten years later, in 1860, the population was 31,443,321 persons, and the coal production amounted to 16,139,736 tons, or an average of 0.514 ton per person. At the census of 1870 the population of the United States amounted to 38,558,371; the coal production of that year amounted to 36,806,560 short tons, a per capita average of 0.96 ton. Ten years later, in 1880, when the population was 50,189,209, the coal output amounted to 76,157,944 short tons, or 1.52 tons per capita. In 1890 the population had grown to 63,069,756, an increase of 25 per cent over 1880, and the coal production had grown to 157,770,963 short tons, or a per capita production of 2.52 tons. At the taking of the Twelfth Census, in 1900, when the increase in population amounted to 22 per cent, the total number of persons reported being 76,303,387, more than 70 per cent had been added to the coal production, with a total of 269,684,027 short tons, or an average of 3.53 tons for each inhabitant. In other words, while the population was increasing 230 per cent from 1850 to 1900 the production of coal increased 4,084 per cent. The report of the Thirteenth Census on population shows that on April 15, 1910, the United States contained 91,972,266 persons, and the production of coal amounted to 501,596,378 short tons, indicating that the per capita coal production in that year was nearly 5.5 short tons. On account of the decreased production of coal in 1911 the per capita consumption was slightly less in that year than in 1910. At the time of writing this report it is apparent that the coal production of 1912 will show a substantial increase over that of the previous high record of 1910.

It is true that in the earlier years covered by this summary the proportion of wood used for fuel was larger than it is at the present time, but the actual consumption of wood for fuel is probably as great today, or possibly greater, than 50 years ago. It should also be remembered that, in addition to the production of coal, there has been a great increase in the use of oil for fuel, and natural gas still remains an important factor in this regard. The consumption of petroleum for fuel in 1911 was probably equivalent to between 35,000,000 and 40,000,000 short tons of coal.

Men and machinery.—The total number of men employed in the coal mines of the United States in 1911 was 722,335, of whom 172,585 men were employed in the anthracite mines of Pennsylvania and 549,750 were employed in the bituminous and lignite mines. In 1910 the anthracite mines gave employment to 169,497 men, and the bituminous and lignite mines to 555,533 men. The anthracite miners have an advantage over the bituminous workers in the larger number of days they are able to work during the year. This condition has been brought about through the policy adopted by the operators several years ago, of allowing discounts during the spring and summer months in order to encourage consumers to lay in their winter supplies and thus avoid the idleness that prevailed in the summer, and the congestion of orders and traffic in the winter. In 1911 the anthracite miners averaged 246 days each, and the bituminous miners 211 days. In 1910 the anthracite workers averaged 229 days during the year, and the bituminous and lignite miners 217 days. The general average number of days for both anthracite and bituminous miners was the same in 1910 as in 1911, namely, 220 days. The average production of coal per man in the anthracite mines in 1911 was 524 short tons for the year and 2.13 tons for each working day; in the bituminous mines the average production per man was 738 tons annually and 3.5 tons for each working day. In 1910 the average production per man in the anthracite mines was 498 tons, and in the bituminous mines, 751 tons, and the average daily production per man was 2.17 and 3.46 tons, respectively, in the anthracite and bituminous mines.

It is doubtful if the great tonnage record made in the production of bituminous coal by the United States in recent years could have been attained with the supply of labor available and at the low prices which have obtained, except for the introduction of labor-saving machinery. In this the greatest part has been played by the machines used for undercutting and shearing the coal. In many cases the installation of machinery has been forced upon the operators in order to meet the constantly increasing competition combined with advances in wages, and yet it also happens that much of the advantage sought has been lost through the differentials in mining rates placed against the machines. More important than the lessening of the mining costs, however, is the reduction of liability to accident by decreasing the proportion of coal shot off the solid. This reprehensible practice of making the powder do the work, in addition to increasing the danger from explosions and fires, weakens the roof and pillars and produces an inordinate quantity of undesirable or unmarketable fuel. Every step taken to eradicate this evil is a step in advance

The present report contains the first statistics compiled which show the proportion of coal mined by machinery, undercut or otherwise mined by hand, and shot off the solid.

In 1911, out of a total of 405,757,101 short tons of bituminous coal and lignite produced, 29.7 per cent was mined by hand, 43.9 per cent was mined by machines, and 17 per cent was shot off the solid, and for 9.4 per cent the mining methods were not reported. The total quantity of bituminous coal and lignite mined by machines in 1911 was 177,971,976 short tons, or 43.89 per cent of the total production. In 1910 the machine-mined production amounted to 174,012,293 short tons, or 41.7 per cent of the total output of bituminous coal and lignite. The total quantity of bitumious coal and lignite produced in the United States in 1911 was 11,354,041 short tons less than in 1910. The quantity of machine-mined coal in 1911 was 3,959,683 tons in excess of that of 1910. The percentage of decrease in the total output was 2.72. The percentage of increase in the machine-mined tonnage was 2.3. The number of machines in use increased from 13,254 in 1910 to 13,819 in 1911, and the average production by each machine was 12,879 tons in 1911, compared with 13,127 tons in 1910.

A noticeable feature in connection with the statistics of the machines employed is the increase in the number of short-wall machines and the advent of the new type of machine represented by the radialaxe or post puncher. Prior to 1911 no statistics covering the number of the latter type of machine in use had been collected. In 1911 there were 83 of these machines reported. The number of short-wall machines increased from 47 in 1910 to 777 in 1911.

Labor troubles.—The coal-mining industry as a whole was not disturbed by serious labor troubles in 1911. In the bituminous regions, where operations are conducted under agreements with the mine-workers' union, the compacts extend from April 1 to March 31 of the "even" years. In the "odd" years, as in 1911, the difficulties are local and are generally short-lived. In the anthracite region of Pennsylvania operations were continued without serious interruptions under the second three-year extension of the awards of the Strike Commission, and the few suspensions that occurred were not sufficient to affect the production. The summation of the strikes or suspensions in the bituminous mines in 1911 was 35,513 men idle (out of a total of 722,335 men) for an average of 27 days. In the preceding odd year (1909) 25,534 men were idle an average of 29 days, and in the intervening even year (1910) 215,640 men were idle for an average of 89 days. The total time lost in 1910 was nearly 20 times that lost in 1911.

Accidents.—The statistics of accidents in the coal mines and in other branches of the mining and quarrying industry in 1911 have been compiled under the direction of the Director of the United States Bureau of Mines. The returns show that 2,719 men were killed in the coal mines in 1911, a decrease from 2,840 in 1910. The most prolific cause of accidents was falls of roof and coal, 1,321 deaths, or 48.6 per cent of the total, being due to that cause. In only two

States—Alabama and Tennessee—were deaths from explosions of dust and gas more numerous than those from falls. The total deaths from explosions (not counting explosions of powder) were 371, or 13.6 per cent of the total. Mine cars and haulage motors killed 393, or 14.4 per cent of the total; premature blasts and powder explosions killed 134, or 4.9 per cent, and 63 men, or 2.3 per cent of the total, met their deaths in shaft accidents. The death rate per thousand employees in 1911 was 3.76 against 3.92 in 1910.

Washed coal.—The production of anthracite in Pennsylvania includes an appreciable quantity of usable fuel recovered from the old culm banks by washeries, and the unsightly monuments to the wasteful methods of early times are disappearing from the landscape in the anthracite region. The quantity of coal recovered in the 22 years since the first washery was constructed in 1890 has amounted to about 50,000,000 long tons, considerably more than the total production of anthracite at the beginning of the period. In 1911 the washery product amounted to 4,136,044 long tons. In addition to the coal recovered from the culm banks, 94,647 long tons in 1911, and 91,833 tons in 1910, were recovered from the bottom of Susquehanna River by dredges.

In the bituminous regions the principal use of washeries is to improve the quality of the slack coal used in the manufacture of coke by reducing the ash and sulphur, although considerable quantities, particularly in Illinois, are washed in the preparation of sized coal for household use. The quantity of bituminous coal washed at the mines in 1911 was 12,543,114 short tons. The washeries yielded 10,999,481 tons of cleaned coal and 1,543,633 tons of refuse.

Consumption.—Practically the entire output of both anthracite and bituminous coal in the United States is consumed within the country. The effort on the part of some of the operators in the Eastern States to build up an export trade has resulted in a considerable expansion of business along this line of some importance in itself but of comparative insignificance when considered with the total production. The total quantity of coal exported in 1911 was 19,524,683 short tons, or a little less than 4 per cent of the production. The consumption of coal of domestic production—that is, the total production less the quantity exported—of 1911 was 476,696,485 short tons. The imports amounted in 1911 to 1,385,956 short tons, which, added to the consumption of domestic coal, made the total consumption in that year 428,082,441 short tons, which is equivalent to 96.32 per cent of the domestic production. In this statement no account is taken of the stock on hand at the beginning and the end of the year. The coal-mining industry is at best of a hand-to-mouth character, and stocks do not figure in the trade.

Most of the coal imported into the United States is classed as bituminous or shale, only a comparatively small quantity of anthracite being brought into this country. The imports of bituminous coal are principally to points on the Pacific coast and to the port of Boston, where considerable quantities of bituminous slack are imported from Canada and used at the Otto-Hoffmann coke ovens at Everett, near Boston. The exports of both anthracite and bituminous coal are principally to Canada.

The statistics of coal production presented in these reports include not only the coal marketed, either by shipment to distant points, or sold locally, but that consumed by mine employees and by the mine owners in the operation of the collieries. The latter factor is usually considered and reported as colliery consumption. There are occasional exceptions in the bituminous fields, where the operators, who use only slack, an otherwise waste product, do not report this item in their statement of production and do not deem it of any value; it is not considered as a portion of the mine product, nor is the miner paid for it in wages. Such exceptions are few and the quantity is negligible. The quantity of coal consumed in the manufacture of coke is also considered in this report.

The quantity of coal consumed in the manufacture of coke at the mines in 1911 was 42,217,167 short tons, as compared with 52,187,450 short tons in 1910, a decrease in 1911 of 9,970,283 tons, or 19 per cent, as compared with a decrease of 1.07 per cent in the total production of coal. The coal shipped to market, used in the manufacture of coke, and sold locally amounted in 1911 to 476,668,328 short tons, as compared with 483,087,320 short tons in 1910. This is usually considered the marketable product. Colliery consumption, which represents the difference between the marketable product and the total output, amounted in 1911 to 19,552,840 short tons. The colliery consumption in the anthracite region, consisting almost entirely of culm or waste material, averages something over 10 per cent of the total anthracite production. In 1911, out of a total production of 80,771,488 long tons, 8,279,488 tons were used in the mines for steam and heat. The colliery consumption in the bituminous regions amounts to about 2.5 per cent of the total output, and in 1911, out of a total of 405,757,101 short tons, 10,279,813 short tons were used in the operation of the properties.

PRODUCTION.

STATISTICS FOR 1910 AND 1911.

The statistics of the production of coal in the United States in 1910 and 1911, by States, with the distribution of the product for consumption, are shown in the tables following:

Coal production of the United States in 1910, by States, in short tons.

State.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Made into coke.	Total quantity.	Total value.	Average price per ton.	Average number of days active.	Average number of employees.
Alabama	10,843,811	206,201	644,007	4,417,443	16,111,462	$20,236,853	$1.26	249	22,230
Arkansas	1,822,022	13,112	70,824		1,905,958	2,979,213	1.56	128	5,568
California and Alaska	6,679	4,985	500		12,164	33,336	2.74	189	19
Colorado	9,563,063	295,164	330,517	1,784,992	11,973,736	17,026,934	1.42	236	15,864
Georgia	94,330	776	2,760	79,379	177,245	259,122	1.46	265	386
Idaho	100	4,348			4,448	17,426	3.92	200	14
Illinois	41,818,730	2,666,614	1,400,352	14,550	45,900,246	52,405,897	1.14	160	72,645
Indiana	17,226,134	771,728	391,953		18,389,815	20,813,659	1.13	229	21,878
Iowa	7,169,039	588,871	170,210		7,928,120	13,903,913	1.75	218	16,666
Kansas	4,574,731	202,472	143,657	591	4,921,451	7,914,709	1.61	148	12,870
Kentucky	13,665,010	528,987	332,731	96,591	14,623,319	14,405,887	.99	221	20,316
Maryland	5,097,347	62,760	57,018		5,217,125	5,835,058	1.12	270	5,809
Michigan	1,355,819	110,473	68,675		1,534,967	2,930,771	1.91	211	3,575
Missouri	2,512,492	413,570	56,371		2,982,433	5,328,285	1.79	154	9,691
Montana	2,657,087	101,613	124,751	37,519	2,920,970	5,329,322	1.82	239	3,837
New Mexico	2,720,641	40,428	46,048	701,204	3,508,321	4,877,151	1.39	283	3,585
North Dakota	269,037	119,377	10,627		399,041	595,139	1.49	207	534
Ohio	31,958,985	1,684,444	560,290	5,949	34,209,668	35,932,288	1.05	203	46,641
Oklahoma	2,435,987	50,821	153,647	5,771	2,646,226	5,867,947	2.22	144	8,657
Oregon	40,497	13,583	13,453		67,533	235,229	3.48	257	153
Pennsylvania, bituminous	108,600,585	2,985,188	3,202,352	35,733,401	150,521,526	153,029,510	1.02	238	175,403
Tennessee	6,255,707	132,750	117,365	615,558	7,121,380	7,925,350	1.11	225	11,930
Texas	1,843,356	20,702	28,118		1,892,176	3,160,965	1.67	234	4,197
Utah	2,129,452	26,207	94,345	267,805	2,517,809	4,224,556	1.68	260	3,053
Virginia	4,063,382	88,284	147,621	2,208,710	6,507,997	5,877,486	.90	241	7,264
Washington	3,522,347	140,931	154,579	94,042	3,911,899	9,764,465	2.50	256	6,314
West Virginia	53,562,518	923,914	1,060,642	6,123,945	61,671,019	56,665,061	.92	228	68,663
Wyoming	7,160,332	88,548	284,208		7,533,088	11,706,187	1.55	248	7,771
Total bituminous	342,969,220	12,286,851	9,667,621	52,187,450	417,111,142	469,281,719	1.12	217	555,533
Pennsylvania, anthracite	73,623,227	2,020,572	8,841,437		84,485,236	160,275,302	1.90	229	169,497
Grand total	416,592,447	14,307,423	18,509,058	52,187,450	501,596,378	629,557,021	1.25	220	725,030

Coal production of the United States in 1911, by States, in short tons.

State.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Made into coke.	Total quantity.	Total value.	Average price per ton.	Average number of days active.	Average number of employees.
Alabama	11,135,563	141,191	615,335	3,129,332	15,021,421	$19,079,949	$1.27	227	22,707
Arkansas	1,996,803	16,560	93,426		2,106,789	3,396,849	1.61	133	5,657
California and Alaska	4,981	5,986	680		11,647	23,297	2.00	265	60
Colorado	8,104,712	303,473	324,947	1,424,251	10,157,383	14,747,764	1.45	207	14,316
Georgia and North Carolina	86,161	1,007	5,485	72,677	165,330	246,448	1.49	277	514
Idaho and Nevada		1,791	30		1,821	4,872	2.68	228	13
Illinois	49,163,827	2,806,197	1,623,319	85,775	53,679,118	59,519,478	1.11	188	76,600
Indiana	13,134,954	657,978	408,423		14,201,355	15,326,808	1.08	182	21,182
Iowa	6,594,899	532,519	204,230		7,331,648	12,663,507	1.73	203	16,599
Kansas	5,932,062	142,624	178,967	575	6,254,228	9,645,572	1.54	189	11,625
Kentucky	12,652,280	604,617	334,444	115,498	13,706,839	13,617,217	.99	191	21,821
Maryland	4,547,600	72,050	66,145		4,685,795	5,197,066	1.11	243	5,881
Michigan	1,347,144	70,127	58,803		1,476,074	2,791,461	1.89	218	3,323
Missouri	3,230,474	456,316	73,817		3,760,607	6,431,066	1.71	183	9,991
Montana	2,739,529	80,985	155,844		2,976,358	5,342,168	1.79	220	3,866
New Mexico	2,308,462	27,264	45,324	767,108	3,148,158	4,525,925	1.44	230	4,007
North Dakota	359,075	130,655	12,898		502,628	720,489	1.43	229	640
Ohio	28,114,734	1,961,939	682,777	536	30,759,986	31,810,123	1.03	179	46,035
Oklahoma	2,840,002	47,274	186,966		3,074,242	6,291,494	2.05	156	8,790
Oregon	22,407	10,216	14,038		46,661	108,033	2.32	179	189
Pennsylvania, bituminous	107,055,470	3,613,660	3,265,496	30,819,537	144,754,163	146,347,858	1.01	233	168,274
Tennessee	5,751,404	97,643	122,146	461,963	6,433,156	7,209,734	1.12	232	10,703
Texas	1,877,901	56,912	39,780		1,974,593	3,273,288	1.66	226	5,353
Utah	2,004,892	27,797	98,790	381,696	2,513,175	4,248,666	1.69	236	3,060
Virginia	5,230,894	82,349	181,660	1,369,764	6,864,667	6,254,804	.91	261	7,392
Washington	3,230,991	155,932	138,140	47,752	3,572,815	8,174,170	2.29	225	6,498
West Virginia	54,171,423	1,045,547	1,073,907	3,540,703	59,831,580	53,670,515	.90	221	66,730
Wyoming	6,386,936	83,932	273,996		6,744,864	10,508,863	1.56	230	7,924
Total bituminous	340,025,580	13,234,541	10,279,813	42,217,167	405,757,101	451,177,484	1.11	211	549,750
Pennsylvania, anthracite	78,894,589	2,296,451	9,273,027		90,464,067	175,189,392	1.94	246	172,585
Grand total	418,920,169	15,530,992	19,552,840	42,217,167	496,221,168	626,366,876	1.26	220	722,335

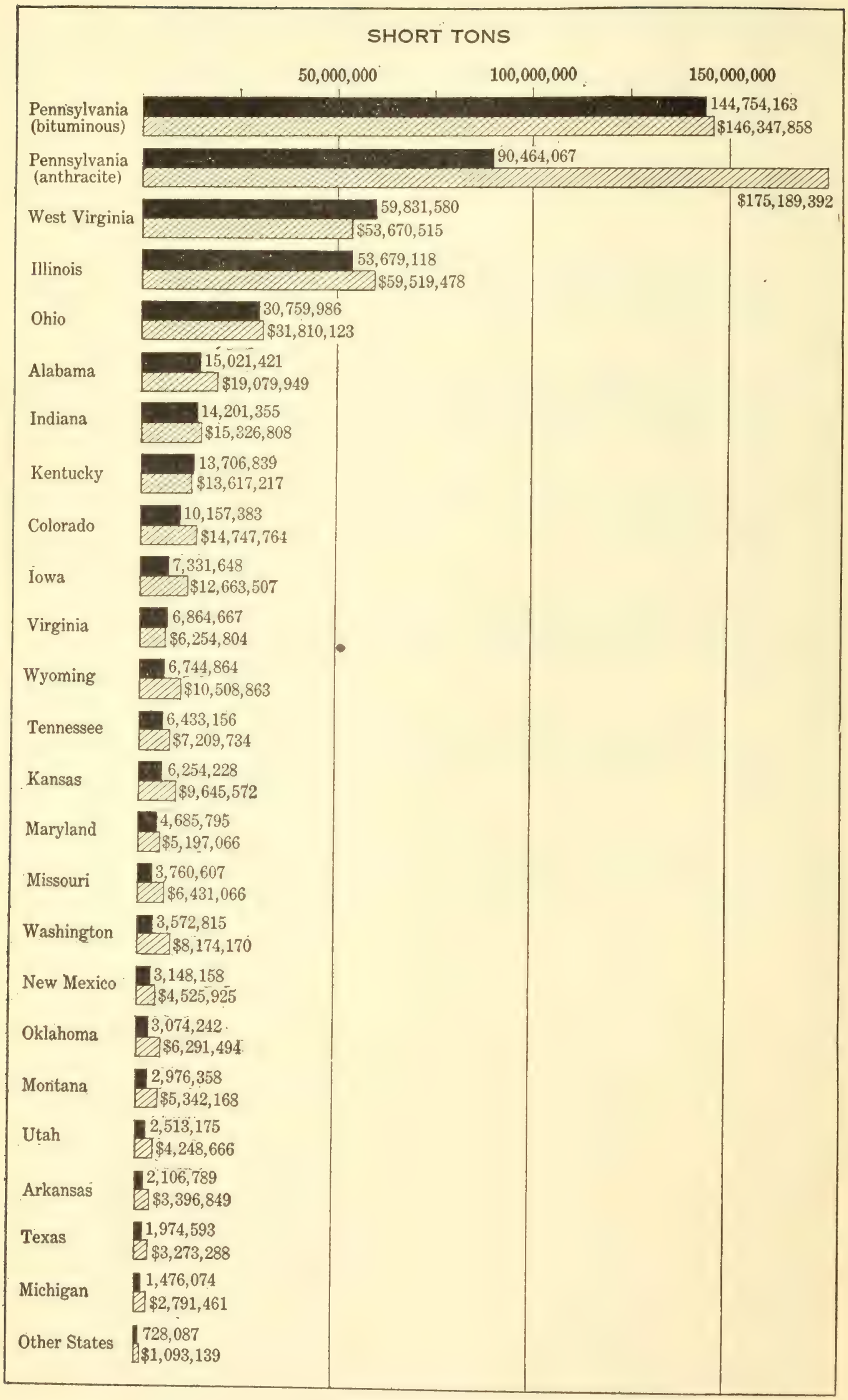

FIGURE 1.—Production of coal in United States in 1911, by States.

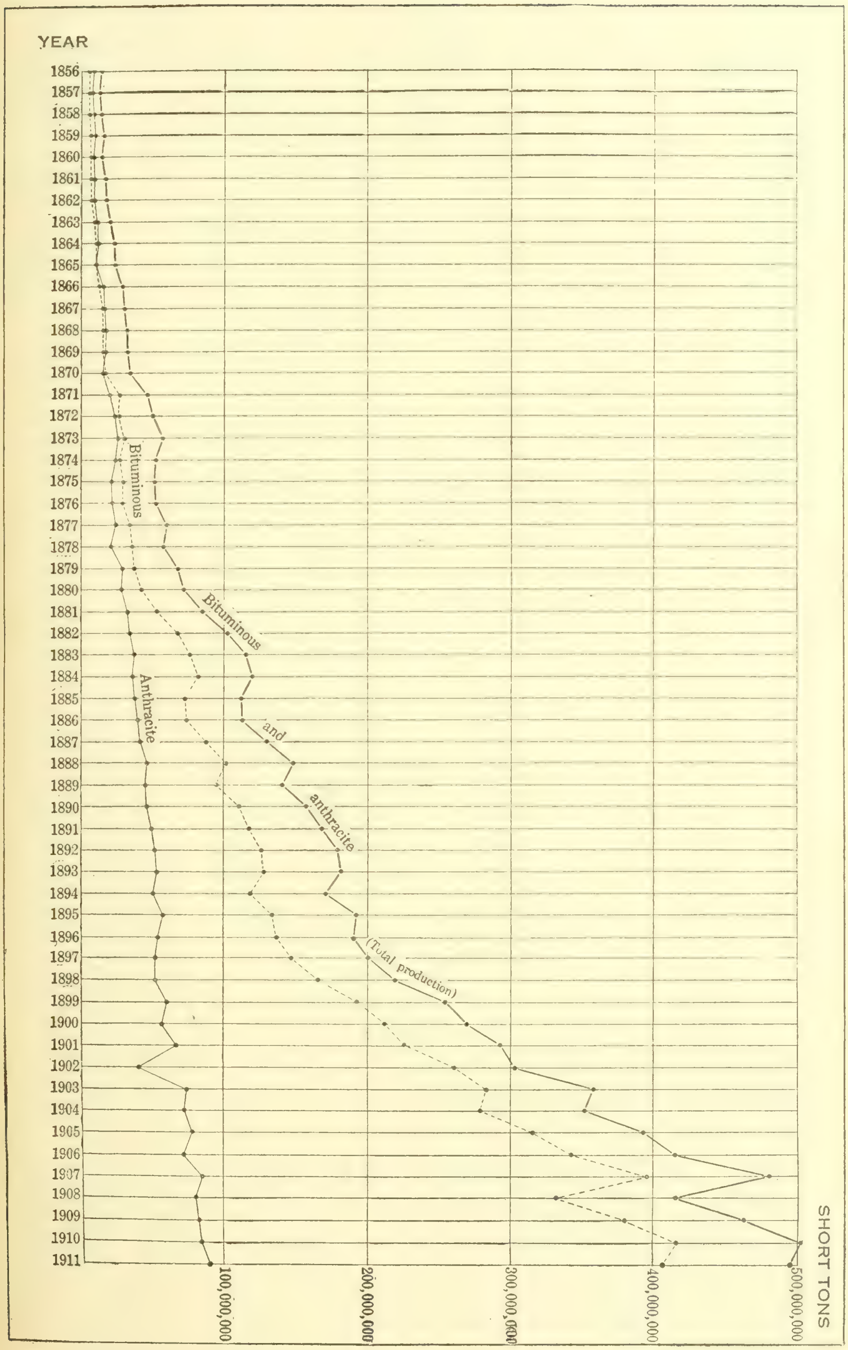

FIGURE 2.—Yearly production of anthracite and bituminous coal from 1856 to 1911, in short tons.

The elimination of Pennsylvania anthracite as a manufacturing fuel, to which reference has already been made, has made increased production of that fuel dependent upon the increase in population in the regions served by it, and upon the variations in temperature. It is, of course, subject to fluctuations due to labor troubles (as indicated on the accompanying diagram (fig. 2), in the production in 1902), but is not affected to anywhere near the same extent as is bituminous coal by trade conditions. The increase in the production of anthracite has been fairly regular, while the increase in bituminous coal production, particularly in the last 25 years, with the development of the United States as a manufacturing country, has been by leaps and bounds. The influence of the business depression of 1908 is shown on the diagram by a marked decrease in the production of bituminous coal, while anthracite was scarcely affected. The maximum production of anthracite was reached in 1911 with a total of 80,771,488 long tons, or 90,464,067 short tons. Prior to 1911 the maximum production was that of 1907, when 76,432,421 long tons, or 85,604,312 short tons, were produced. The production of over 80,000,000 long tons in 1911 puts at rest the prediction formerly made that the production would not exceed a total of 75,000,000 tons annually, and rather indicates that the output will reach 100,000,000 long tons before the period of decline begins. The production of anthracite in 1911 exceeded that of 1891, 20 years ago, by nearly 80 per cent, and was almost three times that of 1881, 30 years before. This rate of increase compares favorably with that of Great Britain, whose total production in 1911 was about 50 per cent more than that of 1891. Germany's production in 1911 was two and one-half times that of 1891. The rate of increase in France was about the same as that of Great Britain and of anthracite in Pennsylvania; but all of these pale somewhat when compared with the rate of increase in the production of bituminous coal in the United States. The bituminous production in this country in 1910 was nearly eight times that of 1881, and more than three and a half times that of 1891. The decrease of something over 11,000,000 tons in 1911 as compared with 1910 reduces these proportions to some extent, but the indications are that 1912 will show a substantial recovery of the temporary setback of 1911. The production of bituminous coal in the United States exceeds the total production of Great Britain by over 100,000,000 short tons, and the total output of Germany by over 150,000,000 short tons. In 1891 the production of bituminous coal in the United States exceeded that of anthracite by 132.7 per cent. In 1911 the bituminous production was 348.5 per cent more than the anthracite, and in 1910, when the maximum production of bituminous coal was obtained, it exceeded that of anthracite by 393.7 per cent.

The accompanying diagram (fig. 2) illustrates the comparative growth in the production of anthracite and bituminous coal from 1856 to 1911. Prior to 1870 the larger portion of the production was in Pennsylvania anthracite, but since 1870 the output of bituminous coal has rapidly outstripped that of anthracite. In 1869 the production of Pennsylvania anthracite was 17,083,134 short tons and the production of bituminous coal was 15,821,226 tons. In the census year of 1870 these figures were nearly reversed, and at the following census of 1880 the production of anthracite amounted to 28,649,812 short tons, and that of bituminous to 42,831,758 short tons. In 1890 the production of anthracite had grown to 46,468,641 short tons, whereas the bituminous production amounted to 111,302,322 short tons. In the next 10 years the production of anthracite increased 23.5 per cent and amounted to 57,367,915 short tons, and the bituminous production increased 91 per cent to 212,316,112 short tons. The statistics for 1911 show that the output of anthracite amounted to 90,464,067 short tons, an increase over 1900 of 33,096,152 short tons, or 57.7 per cent. The production of bituminous coal increased 193,440,989 tons, or 91.1 per cent. The production of anthracite coal in 1911 was more than three times that of 1880 and the production of bituminous was more than nine times.

Anthracite was at one time an important factor in blast-furnace practice, but its use in that line of industry has now almost entirely ceased, having been supplanted by coke made from bituminous coal. The principal demand for anthracite will be in the future, as it has been in the more recent past, restricted largely to domestic trade, for which such sizes as furnace, egg, stove, and chestnut are required. The breaking down of the lump coal, which was formerly a marketable product, for the preparatoin of the domestic sizes, results in a much larger proportion of the small or undesirable sizes, all of which are sold at less than the cost of production. As shown in the subsequent pages of this report, the percentage of these small sizes has increased from 23.1 per cent in 1890 to 40.8 per cent in 1911, while the percentage of sizes above pea coal, or what may be termed the profitable sizes, has decreased from 77 to 59.2 per cent. All of the profits on the mining operations must be obtained from the prepared domestic sizes, for the revenue obtained from the smaller sizes, which are sold largely in competition with bituminous coal for steaming purposes, serves only to reduce the cost of the domestic sizes. The conditions under which the anthracite mines are operated, the greater depths to which the workings are carried, the consequent increased expense of mining, and the increasing cost of labor all contribute to make anthracite fuel more and more a luxury. No hope is held out to the consumer that anthracite will in the future be sold at lower prices than those which prevail to-day, but, on the other hand, there is every reason to believe that prices must advance in accordance with the increasing cost of production. It is only by reason of economical administration that prices are not higher than they are.

During recent years the anthracite operators have adopted the policy of making an allowance of 50 cents per ton from circular prices for domestic coal purchased in April of each year, with an advance of 10 cents per ton for each succeeding month until the schedule prices are restored in September. This has had a more salutary effect in steadying the anthracite trade than any other action taken by those controlling the anthracite industry. Its purpose is to encourage the purchase of coal in the spring and early summer, making the cellars of the consumers the storage places for the following winter, and at the same time to cause the mines to be operated more regularly, thus giving steadier employment to employees throughout the year.

Production of coal in the United States, 1880, 1885, 1890, 1895, 1900, and 1905–1911.

Year.	Pennsylvania anthracite.			Bituminous coal.		
	Quantity.		Value.	Quantity.		Value.
	Long tons.	*Short tons.*		*Long tons.*	*Short tons.*	
1880	25,580,189	28,649,812	$42,196,678	38,242,641	42,831,758	$58,443,718
1885	34,228,548	38,335,974	76,671,948	65,021,715	72,824,321	82,347,648
1890	41,489,858	46,468,641	66,383,772	99,377,073	111,302,322	110,420,801
1895	51,785,122	57,999,337	82,019,272	120,641,244	135,118,193	115,779,771
1900	51,221,353	57,367,915	85,757,851	189,567,957	212,316,112	220,930,313
1905	69,339,152	77,659,850	141,879,000	281,306,058	315,062,785	334,658,294
1906	63,645,010	71,282,411	131,917,694	306,138,274	342,874,867	381,162,115
1907	76,432,421	85,604,312	163,584,056	352,463,493	394,759,112	451,214,842
1908	74,347,102	83,268,754	158,178,849	296,941,021	332,573,944	374,135,268
1909	72,384,249	81,070,359	149,181,587	339,057,372	379,744,257	405,486,777
1910	75,433,246	84,485,236	160,275,302	372,420,663	417,111,142	469,281,719
1911	80,771,488	90,464,067	175,189,392	362,283,126	405,757,101	451,177,484

Year.	Total.		
	Quantity.		Value.
	Long tons.	*Short tons.*	
1880	63,822,830	71,481,570	$100,640,396
1885	99,250,263	111,160,295	159,019,596
1890	140,866,931	157,770,963	176,804,573
1895	172,426,366	193,117,530	197,799,043
1900	240,789,310	269,684,027	306,688,164
1905	350,645,210	392,722,635	476,537,294
1906	369,783,284	414,157,278	513,079,809
1907	428,895,914	480,363,424	614,798,898
1908	371,288,123	415,842,698	532,314,117
1909	411,441,621	460,814,616	554,668,364
1910	447,853,909	501,596,378	629,557,021
1911	443,054,614	496,221,168	626,366,876

Thirty-one States produced coal in 1911, an increase of two over 1910. North Carolina, which had not produced any coal since the Cumnock mines in Chatham County were abandoned in 1905, appeared again as a producer in 1911 with a small output in Moore County, and a few tons were produced in the course of the development of a new mine in Esmeralda County, Nev. This production is interesting only as indicative of future possibilities and did not affect the total, as the output of the two States was less than 150 tons. Of the 31 States which produced coal in 1911, there were only 12, including North Carolina and Nevada, in which the output increased over 1910, and 19 showed decreased production. The principal increases were in the Mississippi Valley States, which had suffered losses in the previous year as a result of the strike which threw most of the miners idle for nearly six months. Illinois, which showed the largest decrease in 1910, had the largest increase in 1911, with a gain of 7,778,872 short tons, and Kansas, which suffered the largest percentage of decrease in 1910, showed the largest percentage of gain (27.08) in 1911, and was second in the quantity of increase (1,332,777 short tons). Missouri, with an increase of 778,174 short tons, was third in this respect, and Oklahoma, with an increase of 428,016 tons, was fourth. Only two States in the Appalachian region (Pennsylvania and Virginia) had a larger production in 1911 than in 1910, and the former owed its escape from a decreased tonnage to a larger output of anthracite. The production of bituminous coal in Pennsylvania decreased 5,767,363 short tons, while that of anthracite increased 5,338,242 long tons (5,978,831 short tons), making a net increase of 211,468 short tons. Virginia's increased production was due to the development of the Clinchfield properties in Russell County following the completion of the Carolina, Clinchfield & Ohio Railway and the opening up of new markets for Virginia coal to the southeast.

The decreased production of bituminous coal was most marked in those States which are also important coke producers and in those which profited in 1910 from the strike in the Mississippi Valley States. Among the coke-producing States the chief decreases were in Pennsylvania bituminous coal, 5,767,363 tons; West Virginia, 1,839,439 tons; Alabama, 1,090,041 tons; and Tennessee, 688,224 tons. The States which owed their decreases in 1911 to the reaction from the increased production due to the strike of the previous year were Ohio, 3,449,682 tons; Indiana, 4,188,460 tons; Kentucky, 916,480 tons; Wyoming, 788,224 tons; Iowa, 596,472 tons; and Maryland, 531,330 tons. Colorado and New Mexico are both coke-making States and both benefited from the strike in 1910. The former's production decreased 1,816,353 tons in 1911 and the latter's 360,163 tons. Washington's production decreased 339,084 tons as the result of the increased consumption of fuel oil.

The production of Pennsylvania anthracite increased from 75,433,246 long tons (or 84,485,236 short tons), valued at $160,275,302, in 19,10, to 80,771,488 long tons (or 90,464,067 short tons), valued at $175 189,392, in 1911. The total production of bituminous coal and lignite decreased from 417,111,142 short tons, valued at $469,281,719, in 1910, to 405,757,101 tons, valued at $451,177,484, in 1911. The decrease in the production of bituminous coal was 11,354,041 short tons, or 2.72 per cent, in quantity, and $18,104,235, or 3.86 per cent, in value. The increase in anthracite production was 5,978,831 short tons, or 7.08 per cent, in quantity and $14,914,090, or 9.13 per cent, in value. The net decrease was 5,375,210 short tons, or 1.07 per cent, in quantity and $3,190,145, or 0.51 per cent, in value.

In the following table is presented a statement of the total production of coal in the last five years, by States, with the increases and decreases in 1911 as compared with 1910:

Quantity and value of coal produced in the United States, 1907–1911, in short tons.

State.	1907		1908	
	Quantity.	Value.	Quantity.	Value.
Alabama	14,250,454	$18,405,468	11,604,593	$14,647,891
Arkansas	2,670,438	4,473,693	2,078,357	3,499,470
California and Alaska	24,089	91,813	21,862	69,650
Colorado	10,790,236	15,079,449	9,634,973	13,586,988
Georgia and North Carolina	[a] 362,401	[a] 499,686	264,822	364,279
Idaho	[b] 7,588	[b] 31,119	5,429	21,832
Illinois	51,317,146	54,687,382	47,659,690	49,978,247
Indiana	13,985,713	15,114,300	12,314,890	13,084,297
Indian Territory (Oklahoma)	3,642,658	7,433,914	2,948,116	5,976,504
Iowa	7,574,322	12,258,012	7,161,310	11,706,402
Kansas	7,322,449	11,159,698	6,245,508	9,292,222
Kentucky	10,753,124	11,405,038	10,246,553	10,317,162
Maryland	5,532,628	6,623,697	4,377,093	5,116,753
Massachusetts			50	150
Michigan	2,035,858	3,660,833	1,835,019	3,322,904
Missouri	3,997,936	6,540,709	3,317,315	5,444,907
Montana	2,016,857	3,907,082	1,920,190	3,771,248
New Mexico	2,628,959	3,832,128	2,467,937	3,368,753

[a] Georgia only.

[b] Includes production of Nebraska and Nevada.

Quantity and value of coal produced in the United States, 1907–1911, in short tons—Con.

State.	1907		1908	
	Quantity.	Value.	Quantity.	Value.
North Dakota	347,760	$560,199	320,742	$522,116
Ohio	32,142,419	35,324,746	26,270,639	27,897,704
Oregon	70,981	166,304	86,259	236,021
Pennsylvania bituminous	150,143,177	155,664,026	117,179,527	118,816,303
Tennessee	6,810,243	8,490,334	6,199,171	7,118,499
Texas	1,648,069	2,778,811	1,895,377	3,419,481
Utah	1,947,607	2,959,769	1,846,792	3,119,338
Virginia	4,710,895	4,807,533	4,259,042	3,868,524
Washington	3,680,532	7,679,801	3,024,943	6,690,412
West Virginia	48,091,583	47,846,630	41,897,843	40,009,054
Wyoming	6,252,990	9,732,668	5,489,902	8,868,157
Total bituminous	394,759,112	451,214,842	332,573,944	374,135,268
Pennsylvania anthracite	85,604,312	163,584,056	83,268,754	158,178,849
Grand total	480,363,424	614,798,898	415,842,698	532,314,117

State.	1909		1910	
	Quantity.	Value.	Quantity.	Value.
Alabama	13,703,450	$16,306,236	16,111,462	$20,236,853
Arkansas	2,377,157	3,523,139	1,905,958	2,979,213
California and Alaska	48,636	107,342	12,164	33,336
Colorado	10,716,936	14,296,012	11,973,736	17,026,934
Georgia	211,196	298,792	177,245	259,122
Idaho	4,553	19,459	4,448	17,426
Illinois	50,904,990	53,522,014	45,900,246	52,405,897
Indiana	14,834,259	15,154,681	18,389,815	20,813,659
Iowa	3,119,377	6,253,367	7,928,120	13,903,913
Kansas	7,757,762	12,793,628	4,921,451	7,914,709
Kentucky	6,986,478	10,083,384	14,623,319	14,405,887
Maryland	10,697,384	10,079,917	5,217,125	5,835,058
Michigan	4,023,241	4,471,731	1,534,967	2,930,771
Missouri	1,784,692	3,199,351	2,982,433	5,328,285
Montana	3,756,530	6,183,626	2,920,970	5,329,322
New Mexico	2,553,940	5,036,942	3,508,321	4,877,151
North Dakota	2,801,128	3,619,744	399,041	595,139
Ohio	422,047	645,142	34,209,668	$35,932,288
Oklahoma	27,939,641	27,789,010	2,646,226	5,867,947
Oregon	87,276	235,085	67,533	235,229
Pennsylvania, bituminous	137,966,791	130,085,237	150,521,526	153,029,510
Tennessee	6,358,645	6,920,564	7,121,380	7,925,350
Texas	1,824,440	3,141,945	1,892,176	3,160,965
Utah	2,266,899	3,751,810	2,517,809	4,224,556
Virginia	4,752,217	4,251,056	6,507,997	5,877,486
Washington	3,602,263	9,158,999	3,911,899	9,764,465
West Virginia	51,849,220	44,661,716	61,671,019	56,665,061
Wyoming	6,393,109	9,896,848	7,533,088	11,706,187
Total bituminous	379,744,257	405,486,777	417,111,142	469,281,719
Pennsylvania, anthracite	81,070,359	149,181,587	84,485,236	160,275,302
Grand total	460,814,616	554,668,364	501,596,378	629,557,021

Quantity and value of coal produced in the United States, 1907–1911, in short tons—Con.

State.	1911		Increase (+) or decrease (—), 1911.		Percentage of increase or decrease, 1911.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Alabama	15,021,421	$19,079,949	−1,090,041	−$1,156,904	− 6.77	− 5.72
Arkansas	2,106,789	3,396,849	+ 200,831	+ 417,636	+ 10.54	+ 14.02
California and Alaska	11,647	23,297	− 517	− 10,039	− 4.25	− 30.11
Colorado	10,157,383	14,747,764	−1,816,353	−2,279,170	− 15.17	− 13.39
Georgia and North Carolina	165,330	246,448	− 11,915	− 12,674	− 6.72	− 4.89
Idaho and Nevada	1,821	4,872	− 2,627	− 12,554	− 59.60	− 72.04
Illinois	53,679,118	59,519,478	+7,778,872	+7,113,581	+ 16.95	+ 13.57
Indiana	14,201,355	15,326,808	−4,188,460	−5,486,851	− 22.78	− 26.36
Iowa	7,331,648	12,663,507	− 596,472	−1,240,406	− 7.52	− 8.92
Kansas	6,254,228	9,645,572	+1,332,777	+1,730,863	+ 27.08	+ 21.87
Kentucky	13,706,839	13,617,217	− 916,480	− 788,670	− 6.27	− 5.47
Maryland	4,685,795	5,197,066	− 531,330	− 637,992	− 10.18	− 10.93
Michigan	1,476,074	2,791,461	− 58,893	− 139,310	− 3.84	− 4.75
Missouri	3,760,607	6,431,066	+ 778,174	+1,102,781	+ 26.09	+ 20.70
Montana	2,976,358	5,342,168	+ 55,388	+ 12,846	+ 1.90	+ 0.24
New Mexico	3,148,158	4,525,925	− 360,163	− 351,226	− 10.27	− 7.20
North Dakota	502,628	720,489	+ 103,587	+ 125,350	+ 25.96	+ 21.06
Ohio	30,759,986	31,810,123	−3,449,682	−4,122,165	− 10.08	− 11.47
Oklahoma	3,074,242	6,291,494	+ 428,016	+ 423,547	+ 16.17	+ 7.22
Oregon	46,661	108,033	− 20,872	− 127,196	− 30.91	− 54.07
Pennsylvania, bituminous	144,754,163	146,347,858	−5,767,363	−6,681,652	− 3.83	− 4.37
Tennessee	6,433,156	7,209,734	− 688,224	− 715,616	− 9.66	− 9.03
Texas	1,974,593	3,273,288	+ 82,417	+ 112,323	+ 4.36	+ 3.56
Utah	2,513,175	4,248,666	− 4,634	+ 24,110	− 0.18	+ 0.57
Virginia	6,864,667	6,254,804	+ 356,670	+ 377,318	+ 5.48	+ 6.42
Washington	3,572,815	8,174,170	− 339,084	−1,590,295	− 8.67	− 16.29
West Virginia	59,831,580	53,670,515	−1,839,439	−2,994,546	− 2.98	− 5.28
Wyoming	6,744,864	10,508,863	− 788,224	−1,197,324	− 10.46	− 10.23
Total bituminous	405,757,101	451,177,484	−11,354,041	−18,104,235	− 2.72	− 3.86
Pennsylvania, anthracite	90,464,067	175,189,392	+5,978,831	+14,914,090	+ 7.08	+ 9.31
Grand total	496,221,168	626,366,876	−5,375,210	−3,190,145	− 1.07	− 0.51

The distribution of the coal production of the United States by five-year periods from 1890 to 1905, and in 1910 and 1911, is shown in the following table. All of the coal made into coke is, of course, bituminous.

Distribution of the coal product of the United States, 1890, 1895, 1900, 1905, 1910, and 1911, in short tons.

Year.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Made into coke.
1890	128,365,965	9,009,285	5,063,953	15,331,760
1895	158,380,289	9,655,505	6,677,539	18,404,197
1900	223,782,088	9,077,242	9,189,746	27,634,951
1905	324,059,447	12,208,687	14,042,173	42,412,328
1910	416,592,447	14,307,423	18,509,058	52,187,450
1911	418,920,169	15,530,992	19,552,840	42,217,167

Year.	Total product.	Total value.	Average price per ton.	Average number of days active.	Average number of employees.
1890	157,770,963	$176,804,573	$1.12	216	318,204
1895	193,117,530	197,799,043	1.02	195	382,879
1900	269,684,027	306,688,164	1.14	212	448,581
1905	392,722,635	476,537,294	1.21	212	626,035
1910	501,596,378	629,557,021	1.25	220	725,030
1911	496,221,168	626,366,876	1.26	220	722,335

The five principal coal-producing States in 1911 were, in order, Pennsylvania, West Virginia, Illinois, Ohio, and Alabama, those five States contributing 80 per cent of the total output for the last 30 years.

The following table has been prepared to show how their production has grown in comparison with the total production since 1860. The statistics are given for each 10 years from 1860 to 1900 and annually from 1901 to 1911. It will be observed that Pennsylvania, which at the beginning of the period (1860) produced practically three-fourths (74 per cent) of the total output of the United States, has yielded less than half the total during the last 10 years, and yet its production in 1911 was more than 20 times that of 1860, showing that the decline in the relative importance of Pennsylvania has been due to the more rapid growth of other States and not to any decline in the coal-mining industry of that State. In the production of bituminous coal Pennsylvania has kept pace pretty closely with the progress in other States and with the development of manufacturing in the United States, but in the production of anthracite, which is no longer a factor as a manufacturing fuel, the progress has been more in sympathy with the growth in population, and, relatively, less rapid than the increase in bituminous production. West Virginia did not become a Commonwealth until 1863 and in 1870 produced less than 2 per cent of the total. It now produces over 12 per cent. The percentage of Illinois is now about double what it was in 1860, and reached its highest point in 1908. Ohio's percentage has declined from 8.7 in 1860 to 6.2 in 1911. Alabama, which produced less than one-tenth of 1 per cent in 1860 and less than one-half of 1 per cent in 1880, now produces about 3 per cent and reached its highest point, 3.4 per cent, in 1902.

Relative production of Pennsylvania, West Virginia, Illinois, Ohio, and Alabama to total output, 1860–1911, in short tons.

Year.	Total production, United States.	Pennsylvania.		West Virginia.	
		Production.	Percentage of total production.	Production.	Percentage of total production.
1860	14,610,042	10,806,628	74.0	....	....
1870	33,035,580	23,462,793	71.0	608,878	1.8
1880	71,481,570	47,074,975	65.9	1,829,844	2.6
1890	157,770,963	88,770,814	56.3	7,394,654	4.7
1900	269,684,027	137,210,241	50.9	22,647,207	8.4
1901	293,299,816	149,777,613	51.1	24,068,402	8.2
1902	301,590,439	139,947,962	46.4	24,570,826	8.1
1903	357,356,416	177,724,246	49.7	29,337,241	8.2
1904	351,816,398	171,094,996	48.6	32,406,752	9.2
1905	392,722,635	196,073,487	49.9	37,791,580	9.6
1906	414,157,278	200,575,617	48.4	43,290,350	10.5
1907	480,363,424	235,747,489	49.1	48,091,583	10.0
1908	415,842,698	200,448,281	48.2	41,897,843	10.1
1909	460,814,616	219,037,150	47.5	51,849,220	11.2
1910	501,596,378	235,006,762	46.9	61,671,019	12.3
1911	496,221,168	235,218,230	47.4	59,831,580	12.1

Relative production of Pennsylvania, West Virginia, Illinois, Ohio, and Alabama to total output, 1860–1911, in short tons—Continued.

Year.	Illinois.		Ohio.		Alabama.	
	Production.	Percentage of total production.	Production.	Percentage of total production.	Production.	Percentage of total production.
1860	728,400	5.0	1,265,600	8.7	10,200	0.07
1870	2,624,163	7.9	2,527,285	7.7	11,000	.03
1880	6,115,377	8.6	6,008,595	8.4	323,972	.45
1890	15,292,420	9.7	11,494,506	7.3	4,090,409	2.6
1900	25,767,981	9.6	18,988,150	7.0	8,394,275	3.1
1901	27,331,552	9.3	20,943,807	7.1	9,099,052	3.1
1902	32,939,373	10.9	23,519,894	7.8	10,354,570	3.4
1903	36,957,104	10.3	24,838,103	7.0	11,654,324	3.3
1904	36,475,060	10.4	24,400,220	6.9	11,262,046	3.2
1905	38,434,363	9.8	25,552,950	6.5	11,866,069	3.0
1906	41,480,104	10.0	27,731,640	6.7	13,107,963	3.2
1907	51,317,146	10.7	32,142,419	6.7	14,250,454	3.0
1908	47,659,690	11.5	26,270,639	6.3	11,604,593	2.8
1909	50,904,990	11.0	27,939,641	6.1	13,703,450	3.0
1910	45,900,246	9.2	34,209,668	6.8	16,111,462	3.2
1911	53,679,118	10.8	30,759,986	6.2	15,021,421	3.0

PRODUCTION OF COAL IN THE UNITED STATES FROM THE EARLIEST TIMES TO THE CLOSE OF 1911.

So far as known, the first mention of the occurrence of coal in the United States is made in the journal of Father Hennepin, a French missionary, who, in 1679, recorded the site of a "cole mine" on Illinois River, near the present city of Ottawa, Ill. The first actual mining of coal was in the Richmond Basin, Va., about 70 years after Father Hennepin's discovery in Illinois, but the first records of production from the Virginia mines were for the year 1822, when, according to one authority, 54,000 tons were mined. Ohio probably ranks second in priority of production, as coal was discovered there in 1755, but the records of production date back only to 1838. The mining of anthracite in Pennsylvania began about 1790, and it is said that in 1807 55 tons were shipped to Columbia, Pa. Reports of the anthracite coal trade are usually begun with the year 1820, when 365 long tons were shipped to Philadelphia from the Lehigh region. Prior to this, however, in 1814, a shipment of 22 tons was made from Carbondale, also to Philadelphia, and in the following table the production is considered to have begun in that year. It is probable that the actual production prior to 1820 was between 2,500 and 3,000 tons.

The following table shows the total production of anthracite in Pennsylvania since 1814, the total production of bituminous coal since 1820, and the total annual production to the close of 1911. During the period covered by this table the total production of anthracite in Pennsylvania has amounted to 2,270,798,737 short tons, that of bituminous coal to 6,468,773,690 short tons, and that of the whole country to 8,739,572,427 short tons. Of the grand total the anthracite mines of Pennsylvania have contributed more than 25 per cent, and less than 75 per cent is represented by the production of bituminous coal.

The annual production of each State, from the time of earliest record to the close of 1911, is given in connection with the discussion of the production in the several States.

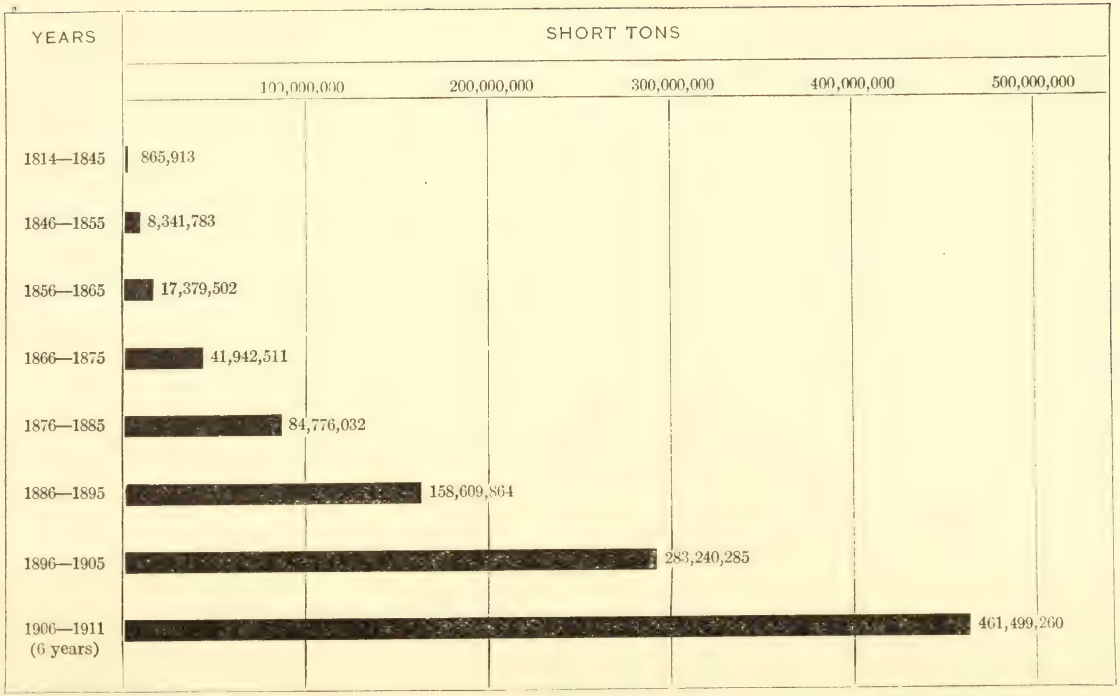

FIGURE 3.—Average yearly production of coal in the United States for each decade since 1814, in short tons.

Production of coal in the United States from 1814 to the close of 1911, in short tons.

Year.	Pennsylvania anthracite.	Bituminous.	Total.	Year.	Pennsylvania anthracite.	Bituminous.	Total.
1814	22	....	22	1864	12,538,649	11,066,474	23,605,123
1815	50	....	50	1865	11,891,746	11,900,427	23,792,173
1816	75	....	75	1866	15,651,183	13,352,400	29,003,583
1817	100	....	100	1867	16,002,109	14,722,313	30,724,422
1818	200	....	200	1868	17,003,405	15,858,555	32,861,960
1819	350	....	350	1869	17,083,134	15,821,326	32,904,360
1820	450	3,000	3,450	1870	15,664,275	17,371,305	33,035,580
1821	1,322	....	1,322	1871	19,342,057	27,543,023	46,885,080
1822	4,583	54,000	58,583	1872	24,233,166	27,220,233	51,453,399
1823	8,563	60,000	68,563	1873	26,152,837	31,449,643	57,602,480
1824	13,685	67,040	80,725	1874	24,818,790	27,787,130	52,605,920
1825	42,988	75,000	117,988	1875	22,485,766	29,862,554	52,348,320
1826	59,194	88,720	147,914	1876	22,793,245	30,486,755	53,280,000
1827	78,151	94,000	172,151	1877	25,660,316	34,841,444	60,501,760
1828	95,500	100,408	195,908	1878	21,689,682	36,245,918	57,935,600
1829	138,086	102,000	240,086	1879	30,207,793	37,898,006	68,105,799
1830	215,272	104,800	320,072	1880	28,649,812	42,831,758	71,481,570
1831	217,842	120,100	337,942	1881	31,920,018	53,961,012	85,881,030
1832	447,550	146,500	594,050	1882	35,121,256	68,429,933	103,551,189
1833	600,907	133,750	734,657	1883	38,456,845	77,250,680	115,707,525
1834	464,015	136,500	600,515	1884	37,156,847	82,998,704	120,155,551
1835	690,854	134,000	824,854	1885	38,335,974	72,824,321	111,160,295
1836	842,832	142,000	984,832	1886	39,035,446	74,644,981	113,680,427
1837	1,071,151	182,500	1,253,651	1887	42,088,197	88,562,314	130,650,511
1838	910,075	445,452	1,355,527	1888	46,619,564	102,040,093	148,659,657
1839	1,008,322	552,038	1,560,360	1889	45,546,970	95,682,543	141,229,513
1840	967,108	1,102,931	2,070,039	1890	46,468,641	111,302,322	157,770,963
1841	1,182,441	1,108,700	2,291,141	1891	50,665,431	117,901,238	168,566,669
1842	1,365,563	1,244,494	2,610,057	1892	52,472,504	126,856,567	179,329,071
1843	1,556,753	1,504,121	3,060,874	1893	53,967,543	128,385,231	182,352,774
1844	2,009,207	1,672,045	3,681,252	1894	51,921,121	118,820,405	170,741,526
1845	2,480,032	1,829,872	4,309,904	1895	57,999,337	135,118,193	193,117,530
1846	2,887,815	1,977,707	4,865,522	1896	54,346,081	137,640,276	191,986,357
1847	3,551,005	1,735,062	5,286,067	1897	52,611,680	147,617,519	200,229,199
1848	3,805,942	1,968,032	5,773,974	1898	53,382,644	166,593,623	219,976,267
1849	3,995,334	2,453,497	6,448,831	1899	60,418,005	193,323,187	253,741,192
1850	4,138,164	2,880,017	7,018,181	1900	57,367,915	212,316,112	269,684,027
1851	5,481,065	3,253,460	8,734,525	1901	67,471,667	225,828,149	293,299,816
1852	6,151,957	3,664,707	9,816,664	1902	41,373,595	260,216,844	301,590,439
1853	6,400,426	4,169,862	10,570,288	1903	74,607,068	282,749,348	357,356,416
1854	7,394,875	4,582,227	11,977,102	1904	73,156,709	278,659,689	351,816,398
1855	8,141,754	4,784,919	12,926,673	1905	77,659,850	315,062,785	392,722,635
1856	8,534,779	5,012,146	13,546,925	1906	71,282,411	342,874,867	414,157,278
1857	8,186,567	5,153,622	13,340,189	1907	85,604,312	394,759,112	480,363,424
1858	8,426,102	5,548,376	13,974,478	1908	83,268,754	332,573,944	415,842,698
1859	9,619,771	6,013,404	15,633,175	1909	81,070,359	379,744,257	460,814,616
1860	8,115,842	6,494,200	14,610,042	1910	84,485,236	417,111,142	501,596,378
1861	9,799,654	6,688,358	16,488,012	1911	90,464,067	405,757,101	496,221,168
1862	9,695,110	7,790,725	17,485,835				
1863	11,785,320	9,533,742	21,319,062		2,270,798,737	6,468,773,690	8,739,572,427

COAL FIELDS OF THE UNITED STATES.

The coal areas of the United States are divided, for the sake of convenience, into two great divisions—anthracite and bituminous.

The areas in which anthracite is produced are confined almost exclusively to the eastern part of Pennsylvania, and usually when the anthracite fields of the United States are referred to those of eastern Pennsylvania are meant. These fields are included in the counties of Susquehanna, Lackawanna, Luzerne, Carbon, Schuylkill, Columbia, Northumberland, Dauphin, and Sullivan, and underlie an area of about 480 square miles. In addition to these well-known anthracite fields of Pennsylvania there are two small areas in the Rocky Mountain region where the coal has been locally anthracited, although the production from these districts has never amounted to as much as 100,000 tons in any one year. One of these localities is in Gunnison County, Colo., and the other in Santa Fe County, N. Mex. The coal, although only locally metamorphosed, is a true anthracite and of a good quality. In previous years some coal, which was classed as anthracite, was mined and sold in New England. The productive area was confined to the eastern part of Rhode Island and the counties of Bristol and Plymouth in Massachusetts. In 1909 redevelopment of the old mines at Portsmouth was in progress, and the result of rehabilitating these properties and of utilizing the product will be watched with interest.

The bituminous and lignite fields are scattered widely over the United States and include an area of something over 496,000 square miles. The previous classification of these coal areas published in earlier volumes of the report Mineral Resources of the United States has been changed as a result of conferences among the geologists working under Marius R. Campbell on the economic geology of coal. The areas are divided, primarily, into six provinces, as follows:

(1) The eastern province, which includes all of the bituminous areas of the Appalachian region; the Atlantic coast region, which includes the Triassic fields near Richmond and Deep River and Dan River fields of North Carolina, and also the anthracite region of Pennsylvania. (2) The Gulf province, which includes the lignite fields of Alabama, Mississippi, Louisiana, Arkansas, and Texas. (3) The interior province, which includes all the bituminous areas of the Mississippi Valley region and the coal fields of Michigan. This province is subdivided into the eastern region, which embraces the coal fields of Illinois, Indiana, and western Kentucky; the western region, which includes the fields of Iowa, Missouri, Nebraska, Kansas, Arkansas, and Oklahoma; and the southwestern region, which includes the coal fields of Texas. The Michigan fields are designated as the northern region of the interior province. (4) The northern or Great Plains province, which includes the lignite areas of North Dakota and South Dakota, and the bituminous and subbituminous areas of northeastern Wyoming and of northern and eastern Montana. (5) The Rocky Mountain province, which includes the coal fields of the portions of Montana and Wyoming which are in the mountainous districts of those States, and all the coal fields of Utah, Colorado, and New Mexico. (6) The Pacific coast province, which includes all of the coal fields of California, Oregon, and Washington.

The report on the production of coal in 1910 contains brief descriptions of the coal fields of the several States and maps of the known coal areas. The report for 1907 contains a map of the coal fields of the United States on a smaller scale. Copies of both of these reports are still available and may be obtained free of charge upon application to the Director of the United States Geological Survey, Washington, D. C. The earlier report contains a statement showing the character and geologic age of the different coals and the estimated tonnage of the various fields. The estimates of tonnage since the publication of that report have been slightly revised by M. R. Campbell, of the Survey, from more recently collated data. The estimates, as now published, are subject to further revision as the result of the Survey's work in the classification of the coal fields in the public land States. The later revision is not available for publication at the time this report goes to press.

The known coal areas of the United States embrace a total area of 310,296 square miles, to which may be added something over 160,000 square miles of which little is known but which may contain workable coals, and about 32,000 square miles where the coal lies under heavy cover and is not considered available under present conditions. The supply of coal before mining began is estimated to have been 3,076,204,000,000 short tons, of which 1,922,979,000,000 tons were considered to be easily accessible and 1,153,225,000,000 short tons to be either so deep or the beds so thin that they are accessible only with difficulty. Classified according to the character of the coal, the original supply consisted of 21,000,000,000 short tons of anthracite, 1,661,457,000,000 tons of bituminous coal, 650,157,000,000 tons of subbituminous coal, and 743,590,000,000 tons of lignite, the supply of bituminous coal being something more than double that of all other grades combined. The total production to the close of 1911 has amounted to 2,270,798,737 short tons of anthracite and 6,468,773,690 tons of bituminous coal, or an aggregate of 8,739,572,427 tons. This total production to the close of 1911 represents, including the waste of coal in mining, an exhaustion of the beds equal to 14,181,980,000 short tons, or somewhat less than 0.5 per cent of the original supply. In other words, the quantity of coal still remaining to be mined amounts to 3,062,022,020,000 short tons, or a little more than 99.5 per cent of the original supply. The annual rate of exhaustion at the present time as represented by the production in 1910 and 1911 is 0.025 per cent of the supply. The quantity of coal still in the ground at the close of 1910 was 6,000 times the production of that year, or, estimating a half ton of coal lost for every ton recovered, the supply is equivalent to 4,000 times the present annual rate of exhaustion.

The following table shows the area known to contain coal in the various States, by fields, the estimated original supply, the total production of each State and field in 1911, the total production in each to the close of 1911, and the estimated supply still available:

Areas of the coal fields by States, estimates of original and present supply, and the production to the close of 1911.

	Area.[a]	Estimated original supply.	Production in 1911.	Total production to close of 1911.	Total exhaustion to close of 1911.	Estimated available supply.
ANTHRACITE.	*Square miles.*	*Short tons.*	*Short tons.*	*Short tons.*	*Short tons.*	*Short tons.*
Pennsylvania	480	21,000,000,000	90,464,067	2,270,798,737	4,540,000,000	16,460,000,000
Colorado and New Mexico	29	(b)	(b)	....	....	(b)
Total	509	21,000,000,000	90,464,067	2,270,798,737	4,540,000,000	16,460,000,000
BITUMINOUS.[c]						
Eastern province.						
Atlantic coast region:						
Virginia	150	(d)	(d)	(d)	(d)	(d)
North Carolina	60	200,000,000	120	476,925	715,000	199,285,000
Appalachian region:						
Pennsylvania	14,200	112,574,000,000	144,754,163	2,396,491,260	3,594,000,000	108,980,000,000
Ohio	12,660	86,028,000,000	30,759,986	611,949,292	918,000,000	85,110,000,000
Maryland	455	8,044,000,000	4,685,795	165,909,802	249,000,000	7,795,000,000
Virginia	1,750	22,500,000,000	6,864,667	79,613,075	120,000,000	22,380,000,000
West Virginia	17,000	150,000,000,000	59,831,580	649,448,201	974,000,000	149,026,000,000
Eastern Kentucky	10,270	67,787,000,000	6,595,102	73,413,698	110,000,000	67,677,000,000
Tennessee	4,400	25,665,000,000	6,433,156	110,416,953	166,000,000	25,499,000,000
Georgia	167	933,000,000	165,210	8,942,169	13,400,000	919,600,000
Alabama	8,430	68,903,000,000	15,021,421	221,175,236	331,000,000	68,572,000,000
Total	69,332	542,434,000,000	275,111,080	4,317,359,686	6,475,400,000	535,958,600,000
Interior province.						
Northern region:						
Michigan	11,000	12,000,000,000	1,476,074	20,473,695	30,000,000	11,970,000,000
Eastern region:						
Indiana	6,500	44,169,000,000	14,201,355	219,180,709	328,000,000	43,841,000,000
Western Kentucky	6,400	36,241,000,000	7,111,737	98,264,971	147,000,000	36,094,000,000
Illinois	35,600	240,000,000,000	53,679,118	844,012,353	1,266,000,000	238,734,000,000
Total	48,500	320,410,000,000	74,992,210	1,161,458,033	1,741,000,000	318,669,000,000

Western and southwestern regions: [e]						
Iowa	12,560	29,160,000,000	7,331,648	171,787,632	258,000,000	28,902,000,000
Missouri	16,700	40,000,000,000	3,760,607	111,434,991	167,200,000	39,832,800,000
Kansas	3,100	7,022,000,000	6,254,228	115,583,869	173,400,000	6,848,600,000
Arkansas	1,684	1,887,000,000	2,106,789	32,224,662	48,000,000	1,839,000,000
Oklahoma	10,000	79,278,000,000	3,074,242	51,632,976	77,400,000	79,200,600,000
Texas	10,200	31,000,000,000	1,974,593	22,031,534	33,000,000	30,967,000,000
Total	54,244	188,347,000,000	24,502,107	504,695,664	757,000,000	187,590,000,000
Rocky Mountain and Northern Great Plains provinces.						
Arizona	30	60,000,000				60,000,000
North Dakota	31,240	500,000,000,000	502,628	4,428,716	6,600,000	499,993,400,000
Montana	34,067	303,060,000,000	2,976,358	35,110,591	52,700,000	303,007,300,000
South Dakota	2,000	10,000,000,000				10,000,000,000
Wyoming	20,568	424,085,000,000	6,744,864	103,979,728	156,000,000	423,929,000,000
Utah	13,130	196,458,000,000	2,513,175	27,981,857	42,000,000	196,416,000,000
Colorado	10,105	371,770,000,000	10,157,383	155,151,364	232,700,000	371,537,300,000
New Mexico	13,331	163,780,000,000	3,148,158	34,250,976	51,300,000	163,728,700,000
Idaho	200	600,000,000	1,821	43,516	65,000	599,935,000
Total	124,671	1,969,813,000,000	[f] 26,044,387	360,946,748	541,365,000	1,969,271,635,000
Pacific coast province and Alaska.						
Washington	1,100	20,000,000,000	3,572,815	57,220,617	85,800,000	19,914,200,000
Oregon	230	1,000,000,000	46,661	2,078,121	3,000,000	997,000,000
California	500	1,000,000,000	10,747	5,117,447	7,700,000	992,300,000
Alaska			900	45,314		
Total	1,830	22,000,000,000	3,631,123	64,461,499	96,500,000	21,903,500,000
Total production, including colliery consumption	[g] 310,296	3,076,204,000,000	496,221,168	8,739,572,427	14,181,980,000	3,062,022,020,000

[a] Known to contain workable coal.

[b] Included in Rocky Mountain and northern Great Plains provinces.

[c] Includes brown coal or lignite, semianthracite, semibituminous, etc., and scattering lots of anthracite.

[d] Included in Appalachian region.

[e] Including Texas lignite fields of Gulf province.

[f] Includes a little coal from Nevada.

[g] Not including 160,705 square miles of which little is known, but which may contain workable coal, and 31,805 square miles where coal lies under heavy cover and is not at present available.

The following statistics cover the annual production of coal in each of the various regions from 1887 to the close of 1911:

Total production of each region, 1887–1911, in short tons.

	Anthracite.	Bituminous.		
		Atlantic coast.	Appalachian.	Northern.
Area [a] square miles	[b] 519	210	69,332	11,000
Year.				
1887	39,548,255	30,000	55,888,088	71,461
1888	43,971,688	33,000	60,966,245	81,407
1889	45,600,487	49,633	62,972,222	67,431
1890	46,468,641	29,608	73,008,102	74,977
1891	50,665,931	37,645	77,984,563	80,307
1892	52,537,467	43,889	83,122,190	77,990
1893	54,061,121	36,878	81,207,168	45,979
1894	51,992,671	68,979	76,278,748	70,002
1895	58,066,516	82,682	90,167,596	112,322
1896	54,425,573	103,483	90,748,305	92,882
1897	52,680,756	116,950	97,128,220	223,592
1898	53,429,739	38,938	114,239,156	315,722
1899	60,514,201	28,353	129,843,906	624,708
1900	57,466,319	57,912	142,298,208	849,475
1901	67,538,536	12,000	150,501,214	1,241,241
1902	41,467,532	39,206	173,274,861	964,718
1903	74,679,799	35,393	185,600,161	1,367,619
1904	73,228,783	9,100	182,606,561	1,342,840
1905	77,734,673	1,557	212,633,324	1,473,211
1906	71,342,659	....	233,473,524	1,346,338
1907	85,666,404	....	266,501,527	2,035,858
1908	83,310,412	....	216,499,163	1,835,019
1909	81,070,359	....	251,630,500	1,784,692
1910	84,485,236	....	287,816,446	1,534,967
1911	90,464,067	120	275,111,080	1,476,074

	Bituminous.			
	Eastern.	Western and Southwestern.	Rocky Mountain, etc.	Pacific coast and Alaska.
Area [a] square miles	48,500	54,244	124,671	1,830
Year.				
1887	14,478,883	10,172,634	3,646,280	854,308
1888	19,173,167	11,842,764	4,583,719	1,385,750
1889	16,240,314	10,036,356	5,048,413	1,214,757
1890	20,075,840	10,470,439	6,205,782	1,435,914
1891	20,327,323	11,023,817	7,245,707	1,201,376
1892	23,001,653	11,635,185	7,577,422	1,333,266
1893	25,502,809	11,651,296	8,468,360	1,379,163
1894	22,430,617	11,503,623	7,175,628	1,221,238
1895	23,599,469	11,749,803	7,998,594	1,340,548
1896	25,539,867	11,759,966	7,925,280	1,391,001
1897	26,414,127	13,164,059	8,854,182	1,641,779
1898	25,816,874	13,988,436	10,042,759	2,104,643
1899	33,181,247	15,320,373	11,949,463	2,278,941
1900	35,358,164	17,549,528	13,398,556	2,705,865
1901	37,450,871	19,665,985	14,090,362	2,799,607
1902	46,133,024	20,727,495	16,149,545	2,834,058
1903	52,130,856	23,171,692	16,981,059	3,389,837
1904	51,682,313	23,273,482	16,344,516	3,328,803
1905	55,255,541	23,265,750	19,303,188	3,055,391
1906	59,457,660	23,086,348	22,064,003	3,386,746
1907	71,598,256	26,856,622	23,929,155	3,775,602
1908	65,774,700	23,645,983	21,644,307	3,133,064
1909	71,598,795	25,821,744	25,158,772	3,735,375
1910	72,634,356	22,276,364	28,857,413	3,991,596
1911	74,992,210	24,502,107	26,044,387	3,631,123

[a] Known to contain workable coal.

[b] Includes 29 square miles in Colorado and New Mexico.

The following table shows how the production in the six principal bituminous areas has developed since 1887 and how the percentages of the total produced in each during the last five years compare with one another. The production in the northern region of Michigan shows the largest percentage of increase in the period since 1887, and the percentage of the total contributed by the Pacific coast has decreased.

Production of the six principal bituminous coal regions in 1887, 1907, 1908, 1909, 1910, and 1911, compared, in short tons.

Region.	1887		1907		1908		1909	
	Quantity.	Percentage of total.	Quantity.	Per centage of total.	Quantity.	Per centage of total.	Quantity.	Per centage of total.
Appalachian	55,888,088	63.11	266,501,527	67.51	216,499,163	65.10	251,630,500	66.26
Eastern	14,478,8 3	16.50	71,598,256	18.13	65,774,700	19.78	71,598,795	18.85
Western	10,172,634	11.49	26,856,622	6.80	23,645,983	7.11	25,821,744	6.80
Northern	71,461	.08	2,035,858	.52	1,835,019	.55	1,784,692	.47
Rocky Mountain	3,646,280	4.15	23,929,155	6.06	21,644,307	6.51	25,158,772	6.63
Pacific coast	854,308	1.00	3,775,602	.96	3,133,064	.94	3,735,375	.98

Region.	1910		1911		Increase in 1911 over 1887.		Increase in 1911 over 1910.	
	Quantity.	Per centage of total.	Quantity.	Per centage of total.	Quantity.	Per centage.	Quantity.	Per centage.
Appalachian	287,816,446	69.00	275,111,080	67.80	219,222,992	392.25	[a]12,705,366	[a]4.41
Eastern	72,634,356	17.41	74,992,210	18.48	60,513,327	417.94	2,357,854	3.25
Western	22,276,364	5.34	24,502,107	6.04	14,329,473	140.86	2,225,743	9.99
Northern	1,534,967	.37	1,476,074	.36	1,404,613	1,965.57	[a]58,893	[a]3.84
Rocky Mountain	28,857,413	6.92	26,044,387	6.42	22,398,107	614.27	[a]2,813,026	[a]9.75
Pacific coast	3,991,596	.96	3,631,123	.89	2,776,815	325.04	[a]360,473	[a]9.03

[a] Decrease.

RANK OF COAL-PRODUCING STATES.

In the following table the States are arranged according to their rank as coal producers—first, in the quantity of coal mined, and, second, in the value of the product.

The first six States maintained the same relative position in 1911 as in 1910, except that Alabama has again taken fifth place, supplanting Indiana, which had held it during the three preceding years, and Illinois again exceeded West Virginia in the value of its output. West Virginia's production amounted to 59,831,580 short tons in 1911, with a value of $53,670,515, while Illinois produced 53,679,118 short tons, valued at $59,519,478, the quantities and values in the two States being almost exactly reversed. The only other change of importance from 1910 to 1911 was the advance of Virginia from twelfth to tenth place, passing Wyoming and Tennessee, Virginia having an increased production in 1911, while the output of both Wyoming and Tennessee declined. In the value of the production, however, Virginia ranks as low as sixteenth, being exceeded in that regard by the following States which had a smaller output, namely: Wyoming, Kansas, Washington, Tennessee, Missouri, and Oklahoma. The character of some of the coal produced in both Virginia and West Virginia is of as high grade as any mined in the United States. The average price per ton in those two States is the lowest paid for any coal in the United States, having been 91 cents in Virginia and 90 cents in West Virginia, in 1911. In only one other State was it less than $1 and that was Kentucky, where it was 99 cents.

In the combined production of anthracite and bituminous coal Pennsylvania is credited with 47.4 per cent in quantity and 51.4 per cent in value of the total output in the United States. Pennsylvania's coal production exceeds that of any other country in the world, with the exception of Great Britain and Germany, and in 1911 the production of Germany exceeded that of Pennsylvania by only 23,005,533 tons. Since 1909 West Virginia has occupied second place with regard to the quantity of coal produced, having superseded Illinois in that year. In the value of the product, however, Illinois maintains a substantial lead over West Virginia.

Rank of coal-producing States in 1910 and 1911, with quantity and value of product and percentage of each.

1910.

Production.				Value.			
Rank.	State or Territory.	Quantity (short tons).	Percentage of total production.	Rank.	State or Territory.	Value.	Percentage of total value.
1	Pennsylvania:			1	Pennsylvania:		
	Anthracite	84,485,236	16.8		Anthracite	$160,275,302	25.5
	Bituminous	150,521,526	30.0		Bituminous	153,029,510	24.3
2	West Virginia	61,671,019	12.3	2	West Virginia	56,665,061	9.0
3	Illinois	45,900,246	9.1	3	Illinois	52,405,897	8.3
4	Ohio	34,209,668	6.8	4	Ohio	35,932,288	5.7
5	Indiana	18,389,815	3.7	5	Indiana	20,813,659	3.3
6	Alabama	16,111,462	3.2	6	Alabama	20,236,853	3.2
7	Kentucky	14,623,319	2.9	7	Colorado	17,026,934	2.7
8	Colorado	11,973,736	2.4	8	Kentucky	14,405,887	2.3
9	Iowa	7,928,120	1.6	9	Iowa	13,903,913	2.2
10	Wyoming	7,533,088	1.5	10	Wyoming	11,706,187	1.9
11	Tennessee	7,121,380	1.4	11	Washington	9,764,465	1.5
12	Virginia	6,507,997	1.3	12	Tennessee	7,925,350	1.3
13	Maryland	5,217,125	1.0	13	Kansas	7,914,709	1.3
14	Kansas	4,921,451	1.0	14	Virginia	5,877,486	.9
15	Washington	3,911,899	.8	15	Oklahoma	5,867,947	.9
16	New Mexico	3,508,321	.7	16	Maryland	5,835,058	.9
17	Missouri	2,982,433	.6	17	Montana	5,329,322	.8
18	Montana	2,920,970	.6	18	Missouri	5,328,285	.8
19	Oklahoma	2,646,226	.5	19	New Mexico	4,877,151	.8
20	Utah	2,517,809	.5	20	Utah	4,224,556	.7
21	Arkansas	1,905,958	.4	21	Texas	3,160,965	.5
22	Texas	1,892,176	.4	22	Arkansas	2,979,213	.5
23	Michigan	1,534,967	.3	23	Michigan	2,930,771	.5
24	North Dakota	399,041	.1	24	North Dakota	595,139	.1
25	Georgia	177,245	.1	25	Georgia	259,122	.1
26	Oregon	67,533		26	Oregon	235,229	
27	California and Alaska	12,164		27	California and Alaska	33,336	
28	Idaho	4,448		28	Idaho	17,426	
	Total	501,596,378	100.0		Total	629,557,021	100.0

Rank of coal-producing States in 1910 and 1911, with quantity and value of product and percentage of each—Continued.

1911.

Production.				Value.			
Rank.	State or Territory.	Quantity (short tons).	Percentage of total production.	Rank.	State or Territory.	Value.	Percentage of total value.
1	Pennsylvania:			1	Pennsylvania:		
	Anthracite	90,464,067	18.2		Anthracite	$175,189,392	28.0
	Bituminous	144,754,163	29.2		Bituminous	146,347,858	23.4
2	West Virginia	59,831,580	12.1	2	Illinois	59,519,478	9.5
3	Illinois	53,679,118	10.8	3	West Virginia	53,670,515	8.6
4	Ohio	30,759,986	6.2	4	Ohio	31,810,123	5.1
5	Alabama	15,021,421	3.0	5	Alabama	19,079,949	3.0
6	Indiana	14,201,355	2.9	6	Indiana	15,326,808	2.4
7	Kentucky	13,706,839	2.8	7	Colorado	14,747,764	2.4
8	Colorado	10,157,383	2.0	8	Kentucky	13,617,217	2.2
9	Iowa	7,331,648	1.5	9	Iowa	12,663,507	2.0
10	Virginia	6,864,667	1.4	10	Wyoming	10,508,863	1.7
11	Wyoming	6,744,864	1.4	11	Kansas	9,645,572	1.5
12	Tennessee	6,433,156	1.3	12	Washington	8,174,170	1.3
13	Kansas	6,254,228	1.3	13	Tennessee	7,209,734	1.2
14	Maryland	4,685,795	.9	14	Missouri	6,431,066	1.0
15	Missouri	3,760,607	.7	15	Oklahoma	6,291,494	1.0
16	Washington	3,572,815	.7	16	Virginia	6,254,804	1.0
17	New Mexico	3,148,158	.6	17	Montana	5,342,168	.9
18	Oklahoma	3,074,242	.6	18	Maryland	5,197,066	.8
19	Montana	2,976,358	.6	19	New Mexico	4,525,925	.7
20	Utah	2,513,175	.5	20	Utah	4,248,666	.7
21	Arkansas	2,106,789	.4	21	Arkansas	3,396,849	.5
22	Texas	1,974,593	.4	22	Texas	3,273,288	.5
23	Michigan	1,476,074	.3	23	Michigan	2,791,461	.4
24	North Dakota	502,628	.1	24	North Dakota	720,489	.1
25	Georgia and North Carolina	165,330	.1	25	Georgia and North Carolina	246,448	.1
26	Oregon	46,661		26	Oregon	108,033	
27	California and Alaska	11,647		27	California and Alaska	23,297	
28	Idaho and Nevada	1,821		28	Idaho and Nevada	4,872	
	Total	496,221,168	100.0		Total	626,366,876	100.0

PRODUCTION BY CLASSES OF MINES.

In the following tables the production of coal in the United States in 1910 and 1911 has been distributed according to the importance of the producing mines. The mines have been divided into five classes: First, mines producing 200,000 short tons or more during the year; second, mines producing from 100,000 to 200,000 short tons; third, mines producing between 50,000 and 100,000 short tons; fourth, mines producing between 10,000 and 50,000 tons; and fifth, mines producing less than 10,000 tons. In this compilation no account is taken of the small mines operated for purely local trade nor of the anthracite recovered from old culm banks or river beds. Some producers in making their reports to the Survey combine the production of two or more mines on one schedule; in such cases the production of each mine has been assumed to be the average of all of the mines covered by the schedule.

These tables present some interesting comparisons and differences. The concentration of the anthracite industry of Pennsylvania into strong and relatively few units is shown by the fact that in 1911 nearly 75 per cent of the mines were producers of more than 100,000 tons each and that all but 3 per cent of the total production was from this group of mines. The anthracite mines exclusively in the first class (those producing over 200,000 tons each) yielded 87.2 per cent of the total output, and the 168 mines included in this class had an average production of 444,697 tons each. In 1910 there were 157 anthracite mines in the first class and their average production was 419,035 tons each, and in 1909 170 mines had an average production of 386,688 tons each.

In bituminous production a marked decrease is shown in the number of and production by the mines included in the first class, though the average production for each mine in the class increased. The total number of bituminous mines of the first class decreased from 618 in 1910 to 567 in 1911, the total production from them decreased from 191,518,675 short tons to 178,750,494 tons, their percentage of the total production decreased from 46 to 44.2, and the average production from each mine increased from 309,901 to 315,257 tons. On the other hand, the number of second-class mines, those producing between 100,000 and 200,000 tons, increased from 763 to 794, the total production from them increased from 107,052,053 to 114,781,671 tons, the average production per mine increased from 140,304 tons to 144,561 tons, and their percentage of the total increased from 25.7 to 28.3. The reason for this change lies chiefly in the decreases in quantity of coal made into coke, many of the mines producing coal for coke making being included in the first class. The principal decreases in the number of and production by mines of the first class were in the three leading producers of coking coal, Pennsylvania, Alabama, and West Virginia. The combined production of classes 1 and 2 decreased about 5,000,000 tons, from 298,570,728 tons in 1910 to 293,532,165 tons in 1911. The decrease in the production of coal made into coke at the mines decreased about 10,000,000 tons.

It is further to be observed that whereas in 1911 57.5 per cent of the anthracite mines were of the first class and produced 87.2 per cent of the total, only 9.6 per cent of the number of bituminous mines were in this class, but this 9.6 per cent produced 44.2 per cent of the total bituminous output. As for the first three classes of mines—that is, all that produced over 50,000 tons—it is found that 99 per cent of the anthracite production and 87.6 per cent of the bituminous output in 1911 were from these mines, approximately the same proportions as in 1910.

Among the States producing bituminous coal the three which lead in the proportion of output from large units are in the Rocky Mountains—New Mexico, Utah, and Montana—the first having 81.6 per cent of its total in 1911 from mines of the first class, Utah having 76.5 per cent, and Montana 65.4 per cent. In New Mexico 8 mines out of 38 in 1911 and 9 mines out of 31 in 1910 produced over 200,000 tons each, averaging 320,900 tons in 1911 and 343,058 tons in 1910. In Utah 5 mines out of 25 in 1911 and 5 out of 22 in 1910 were in the first class, the average for each of the 5 mines being 383,917 tons in 1911 and 387,350 tons in 1910. Montana had 5 mines out of 49 in 1911 and 4 out of 57 in 1910, the average production from each mine in the two years being, respectively, 388,665 and 476,812 tons, the percentage of the total being the same in both years. The largest average production from mines of the first class in 1911, as in 1910, was in Maryland, the averages being, respectively, 629,999 tons and 583,044 tons. There were only three States east of Mississippi River in which more than half of the total bituminous production in 1911 was from mines of the first class. These three States were Pennsylvania, Illinois, and Virginia. In 1910 Pennsylvania was the only State east of the Mississippi in which more than 50 per cent of the total production was from mines of the first class. West Virginia, the second State in coal-producing importance, has the larger part of its production from mines of the second class, with mines of the first class only a good second in quantity and percentage of coal produced. Mines of the second class in West Virginia produced in 1911 22,106,516 tons, or 37 per cent of the total, while those of the first class produced 16,465,754 tons, or 27.6 per cent. In the report for 1910 attention was called to the influence exerted by the strike in reducing the number of first-class mines in Illinois from 97 to 58 and decreasing the percentage of production from these mines from 60 to 44. The returns for 1911 show that the number of first-class mines in Illinois increased again to 93 and the percentage of production to 59. Pennsylvania, which in 1910 had 62.1 per cent of its bituminous production reported from first-class mines, had 59 9 per cent in 1911. Virginia's percentage from mines of the first class decreased from 63.3 in 1909 to 43.4 in 1910 and increased to 64.6 in 1911. Alabama and most of the States in the Mississippi Valley region (excluding Illinois) have the larger part of their production from mines of the second class.

Production of coal in the United States in 1910 and 1911 according to classes of mines, in short tons

1910

State	First class. Mines producing over 200,000 tons					Second class. Mines producing from 100,000 to 200,000 tons					Third class. Mines producing from 50,000 to 100,000 tons				
	Mines		Production			Mines		Production			Mines		Production		
	Number	Per cent age	Total	Average per mine	Per cent age	Number	Per cent age	Total	Average per mine	Per cent age	Number	Per cent age	Total	Average per mine	Per cent age
Alabama	10	6.1	1,103,606	110,360	36.0	60	33.0	6,917,110	115,285	43.6	37	16.8	2,722,195	73,573	16.9
Arkansas						6	7.9	673,190	112,198	32.5	9	11.8	615,999	68,444	31.2
California															
Colorado	10	6.4	4,136,701	413,670	40.1	30	10.6	3,400,167	113,339	29.9	31	16.3	2,135,513	68,888	20.3
Georgia						1	33.3	161,073	161,073	65.3					
Idaho															
Illinois	60	10.3	20,151,755	335,863	44.0	103	10.1	14,406,516	139,869	31.1	96	17.1	7,103,676	73,996	15.7
Indiana	20	11.6	7,676,104	383,805	41.5	40	16.3	6,056,177	151,404	33.1	34	13.6	2,626,622	77,254	15.8
Iowa	3	.7	933,080	311,027	4.9	26	9.3	3,362,233	129,316	41.1	27	10.1	1,976,610	73,208	25.0
Kansas						3	1.3	390,145	130,048	5.9	40	26.8	2,799,569	69,989	42.3
Kentucky	9	3.1	3,327,103	369,678	16.0	43	11.6	6,393,011	148,675	30.6	52	17.9	3,511,406	67,527	21.2
Maryland	4	4.6	2,333,171	583,293	44.8	6	6.9	920,049	153,341	17.6	12	16.1	861,591	71,799	16.5
Michigan						6	10.0	667,673	111,279	33.5	9	20.1	645,336	71,704	32.1
Missouri						3	1.4	363,336	121,112	12.7	15	7.2	1,099,818	73,321	38.3
Montana	4	7.0	1,907,340	476,835	63.1	3	5.3	414,145	138,048	13.7	1	1.8	61,952	61,952	2.1
New Mexico	9	30.1	3,002,631	333,626	88.3	1	3.3	111,311	111,311	3.3	1	3.3	73,106	73,106	2.1
North Dakota						1	2.3	130,197	130,197	30.7					
Ohio	50	7.3	14,963,670	299,273	44.0	80	9.9	10,146,663	126,833	29.9	57	6.8	3,992,830	69,190	11.4
Oklahoma						3	2.0	300,960	100,320	7.6	17	11.1	1,136,133	66,831	43.1
Oregon															
Pennsylvania bituminous	300	10.0	69,159,111	230,530	63.1	190	13.9	25,065,931	131,926	16.0	264	17.2	19,406,746	73,164	12.2
Tennessee	4	4.1	1,067,400	266,850	21.0	13	9.3	1,657,373	127,490	23.1	27	20.9	1,834,580	67,947	25.7
Texas	1	3.1	233,451	233,451	11.6	3	1.6	395,079	131,693	13.1	10	33.3	731,690	73,169	32.7
Utah	6	33.3	1,600,750	266,792	77.0	3	15.0	365,284	121,761	14.6	2	9.1	121,304	60,652	4.5
Virginia	7	11.1	3,027,133	432,448	43.1	19	30.6	3,110,030	163,686	33.9	14	22.2	916,380	65,456	11.1
Washington	9	10.5	2,331,311	259,035	58.7	6	10.1	673,923	112,321	15.6	11	23.9	720,553	65,505	16.8
West Virginia	89	11.6	31,000,117	348,316	50.1	130	19.1	18,060,236	138,925	30.6	157	27.8	11,091,812	71,540	22.5
Wyoming	10	31.3	4,318,011	431,801	60.1	16	24.3	2,317,676	144,855	31.6	7	10.6	467,512	66,787	6.4
Total bituminous	616	10.0	191,915,676	311,551	46.0	703	13.4	101,052,053	143,744	25.7	969	16.6	68,858,773	71,237	16.6
Pennsylvania anthracite	157	51.0	66,750,454	425,162	81.6	64	20.8	10,661,619	166,588	13.1	26	8.4	2,281,371	87,745	2.9
Grand total	773	13.7	258,666,130	334,626	51.9	767	13.6	111,713,672	145,650	22.1	986	16.1	71,140,144	72,150	14.3

State.	Fourth class. Mines producing from 10,000 to 50,000 tons.					Fifth class. Mines producing less than 10,000 tons.					Total.		
	Mines.		Production.			Mines.		Production.					
	Number.	Percentage.	Total.	Average per mine.	Percentage.	Number.	Percentage.	Total.	Average per mine.	Percentage.	Mines.	Quantity.	Average per mine.
Alabama	77	34.8	2,089,845	27,141	13.0	39	17.7	174,107	4,464	1.1	221	16,111,152	72,901
Arkansas	21	33.3	545,989	25,999	28.7	28	44.5	119,058	4,252	6.2	63	1,905,538	30,247
California	....	....	....	....	....	4	100.0	11,164	2,791	100.0	4	11,164	2,791
Colorado	54	28.3	1,468,896	27,202	12.3	68	35.6	140,671	2,069	1.2	191	11,969,038	62,665
Georgia	1	33.3	25,000	25,000	14.1	1	33.3	1,172	1,172	.7	3	177,245	59,082
Idaho	....	....	....	....	....	3	100.0	4,448	1,483	100.0	3	4,448	1,483
Illinois	129	23.0	3,378,019	26,186	7.4	177	31.5	696,311	3,934	1.5	562	45,818,677	81,528
Indiana	38	15.1	1,063,026	27,974	5.8	104	41.4	324,514	3,120	1.8	251	18,351,724	73,114
Iowa	76	28.4	1,847,480	24,309	23.4	138	51.5	336,268	2,437	4.3	268	7,893,710	29,454
Kansas	54	34.8	1,523,246	28,208	31.2	59	38.1	272,847	4,625	5.6	155	4,883,180	31,504
Kentucky	91	31.4	2,580,920	28,362	17.7	96	33.1	373,681	3,893	2.6	290	14,535,210	50,121
Maryland	27	37.0	907,999	33,630	17.5	24	32.9	74,768	3,115	1.4	73	5,203,152	71,276
Michigan	12	37.5	213,600	17,800	13.9	5	15.6	7,168	1,434	.5	32	1,533,781	47,931
Missouri	38	18.3	810,253	21,322	28.2	152	73.1	595,418	3,917	20.8	208	2,868,927	13,793
Montana	17	29.8	410,288	24,135	14.1	32	56.1	94,136	2,942	3.2	57	2,917,473	51,184
New Mexico	8	25.8	162,029	20,254	4.6	12	38.7	33,335	2,778	1.0	31	3,500,335	112,914
North Dakota	7	15.9	158,895	22,699	42.8	36	81.8	76,361	2,121	20.5	44	371,453	8,442
Ohio	167	24.2	3,984,206	23,858	11.7	348	50.4	1,039,496	2,987	3.1	690	34,017,710	49,301
Oklahoma	46	46.9	1,153,991	25,087	43.7	33	33.7	148,824	4,510	5.6	98	2,640,214	26,941
Oregon	2	18.2	51,119	25,560	76.3	9	81.8	15,880	1,764	23.7	11	66,999	6,091
Pennsylvania bituminous	367	24.8	9,990,563	27,222	6.7	376	25.5	1,469,688	3,909	1.0	1,476	150,409,834	101,904
Tennessee	53	41.1	1,552,378	29,290	21.8	30	23.3	105,154	3,505	1.5	129	7,119,842	55,193
Texas	26	60.5	675,620	25,985	35.7	4	9.3	7,749	1,937	.4	43	1,892,176	44,004
Utah	2	9.1	64,530	32,265	2.6	10	45.5	27,234	2,723	1.1	22	2,515,599	114,345
Virginia	20	31.8	583,268	29,163	9.0	9	14.3	38,289	4,254	.6	63	6,505,300	103,259
Washington	11	22.9	291,184	26,471	7.4	12	25.0	39,559	3,297	1.0	48	3,911,899	81,498
West Virginia	218	30.5	6,551,193	30,051	10.6	79	11.0	287,188	3,635	.5	716	61,605,618	86,041
Wyoming	6	9.1	198,484	33,081	2.6	21	31.9	46,747	2,226	.6	66	7,530,859	114,104
Total bituminous	1,568	27.0	42,282,021	26,966	10.2	1,909	32.8	6,561,235	3,437	1.6	5,818	416,272,257	71,549
Pennsylvania anthracite	28	9.1	812,517	29,018	1.0	33	10.7	147,808	4,479	.2	308	79,695,599	258,752
Grand total	1,596	26.0	43,094,538	27,002	8.7	1,942	21.7	6,709,043	3,458	1.4	6,126	495,967,856	80,961

Production of coal in the United States in 1910 and 1911 according to classes of mines, in short tons—Continued.

1911.

State.	First class. Mines producing over 200,000 tons.					Second class. Mines producing from 100,000 to 200,000 tons.					Third class. Mines producing from 50,000 to 100,000 tons.				
	Mines.		Production.			Mines.		Production.			Mines.		Production.		
	Number.	Percentage.	Total.	Average per mine.	Percentage.	Number.	Percentage.	Total.	Average per mine.	Percentage.	Number.	Percentage.	Total.	Average per mine.	Percentage.
Alabama	11	5.2	3,178,290	288,935	21.2	45	21.3	6,945,637	154,347	46.3	40	19.0	2,887,974	72,199	19.1
Arkansas	1	1.7	255,938	255,938	12.2	6	10.2	805,994	134,332	38.2	9	15.2	606,533	67,393	28.8
California	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......
Colorado	11	6.5	3,208,848	291,713	31.6	25	14.8	3,318,349	132,734	32.7	31	18.3	2,039,403	65,787	20.1
Georgia	......	......	......	......	......	1	50.0	148,936	148,936	90.1	......	......	......	......	......
Idaho	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......
Illinois	93	16.1	31,650,391	340,327	59.0	95	16.4	13,831,544	145,595	25.8	61	10.5	4,386,730	71,914	8.2
Indiana	15	5.8	3,961,824	264,122	28.0	39	15.2	5,832,325	149,547	41.2	35	13.6	2,445,817	69,880	17.3
Iowa	4	1.7	1,042,971	260,743	14.3	21	8.9	2,989,310	142,348	40.9	22	9.3	1,530,006	69,546	21.0
Kansas	1	.6	226,674	226,674	3.7	23	14.4	2,974,190	129,313	47.7	24	15.0	1,651,097	68,796	26.5
Kentucky	6	1.9	1,646,860	274,477	12.2	35	11.5	4,862,575	138,931	35.9	53	17.4	3,705,657	69,918	27.4
Maryland	3	3.8	1,889,996	629,999	40.5	6	7.6	851,723	141,954	18.2	9	11.4	721,921	80,213	15.5
Michigan	1	3.9	202,329	202,329	13.7	4	15.4	499,247	124,812	33.8	9	34.6	664,344	73,816	45.0
Missouri	2	.9	442,975	221,488	12.1	6	2.6	829,749	138,292	22.7	12	5.2	857,476	71,456	23.5
Montana	5	10.2	1,943,326	388,665	65.4	3	6.1	435,951	145,317	14.7	3	6.1	220,468	73,489	7.4
New Mexico	8	21.0	2,567,197	320,900	81.6	2	5.3	315,167	157,584	10.0	......	......	......	......	......
North Dakota	......	......	......	......	......	1	1.7	167,714	167,714	35.1	1	1.7	57,600	57,600	12.0
Ohio	38	5.6	10,871,319	286,087	35.6	67	9.9	9,854,243	147,078	32.3	66	9.7	4,842,037	73,364	15.8
Oklahoma	1	.9	201,127	201,127	6.6	4	3.6	455,647	113,912	14.8	16	14.3	1,120,606	70,038	86.5
Oregon	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......
Pennsylvania bituminous	269	18.1	86,556,892	321,773	59.9	215	14.5	31,223,915	145,228	21.6	211	14.2	15,148,823	71,795	10.5
Tennessee	6	4.6	1,605,900	267,650	25.0	11	8.4	1,509,505	137,228	23.5	24	18.5	1,661,340	69,223	25.8
Texas	......	......	......	......	......	......	......	......	......	......	17	37.8	1,293,044	76,061	65.5
Utah	5	20.0	1,919,585	383,917	76.5	4	16.0	424,050	106,013	16.9	......	......	......	......	......
Virginia	10	16.4	4,434,445	443,445	64.6	6	9.8	965,819	160,970	14.1	11	18.0	776,325	70,595	11.3
Washington	5	10.0	1,281,115	256,223	35.9	8	16.0	1,222,558	152,820	34.2	7	14.0	645,015	92,145	18.0
West Virginia	59	7.8	16,465,754	279,081	27.6	153	20.2	22,106,516	144,487	37.0	184	24.4	12,982,737	70,558	21.7
Wyoming	13	18.8	3,196,738	245,903	47.4	14	20.3	2,211,007	157,929	32.8	11	16.0	774,181	70,380	11.5
Total bituminous	567	9.6	178,750,494	315,257	44.2	794	13.5	114,781,671	144,561	28.3	856	14.5	61,019,134	71,284	15.1
Pennsylvania anthracite	168	57.5	74,709,145	444,697	87.2	50	17.1	8,514,667	170,293	9.9	21	7.2	1,607,527	76,549	1.9
Grand total	735	11.9	253,459,639	344,843	51.7	844	13.7	123,296,338	146,086	25.1	877	14.2	62,626,661	71,410	12.8

State.	Fourth class. Mines producing from 10,000 to 50,000 tons.					Fifth class. Mines producing less than 10,000 tons.					Total.		
	Mines.		Production.			Mines.		Production.					
	Number.	Percentage.	Total.	Average per mine.	Percentage.	Number.	Percentage.	Total.	Average per mine.	Percentage.	Mines.	Quantity.	Average per mine.
Alabama	74	35.1	1,841,776	24,889	12.3	41	19.4	167,545	4,086	1.1	211	15,021,222	71,191
Arkansas	19	32.2	343,022	18,054	16.3	24	40.7	94,750	3,948	4.5	59	2,106,237	35,699
California	......	......	......	......	......	2	100.0	10,747	5,374	100.0	2	10,747	5,374
Colorado	50	29.6	1,406,744	28,135	13.9	52	30.8	172,644	3,320	1.7	169	10,145,988	60,035
Georgia	1	50.0	16,274	16,274	9.9	......	......	......	......	......	2	165,210	82,605
Idaho	......	......	......	......	......	2	100.0	1,805	903	100.0	2	1,805	903
Illinois	120	20.7	3,079,412	25,662	5.8	210	36.3	657,942	3,133	1.2	579	53,606,019	92,584
Indiana	60	23.4	1,564,782	26,080	11.1	108	42.0	344,769	3,192	2.4	257	14,149,517	55,056
Iowa	60	25.3	1,396,644	23,277	19.1	130	54.8	345,896	2,661	4.7	237	7,304,827	30,822
Kansas	43	26.9	1,136,431	26,429	18.2	69	43.1	243,916	3,535	3.9	160	6,232,308	38,952
Kentucky	107	35.1	2,924,058	27,328	21.6	104	34.1	396,783	3,815	2.9	305	13,535,933	44,380
Maryland	35	44.3	1,117,148	31,919	23.9	26	32.9	88,993	3,423	1.9	79	4,669,781	59 111
Michigan	5	19.2	86,083	17,217	5.9	7	26.9	23,732	3,390	1.6	26	1,475,735	56,759
Missouri	48	20.8	1,018,666	21,222	27.9	163	70.5	502,625	3,084	13.8	231	3,651,491	15,807
Montana	11	22.5	289,578	26,325	9.7	27	55.1	82,016	3,038	2.8	49	2,971,339	60,640
New Mexico	9	23.7	224,026	24,892	7.1	19	50.0	40,994	2,158	1.3	38	3,147,384	82,826
North Dakota	7	11.6	131,717	18,817	27.6	51	85.0	121,035	2,373	25.3	60	478,066	7,968
Ohio	154	22.7	3,877,190	25,177	12.8	353	52.1	1,064,478	3,016	3.5	678	30,509,267	44,999
Oklahoma	43	38.4	1,049,672	24,411	34.2	48	42.8	243,318	5,069	7.9	112	3,070,370	27,414
Oregon	1	11.1	30,365	30,365	65.1	8	88.9	16,296	2,037	34.9	9	46,661	5,185
Pennsylvania bituminous	356	23.9	10,054,433	28,243	6.9	436	29.3	1,594,265	3,657	1.1	1,487	144,578,378	97,228
Tennessee	52	40.0	1,476,126	28,387	23.0	37	28.5	177,197	4,789	2.7	130	6,430,068	49,462
Texas	23	51.1	650,257	28,272	32.9	5	11.1	31,292	6,258	1.6	45	1,974,593	43,880
Utah	5	20.0	156,982	31,396	6.2	11	44.0	9,905	900	.4	25	2,510,522	100,421
Virginia	26	42.6	659,769	25,376	9.6	8	13.2	26,977	3,372	.4	61	6,863,335	112,514
Washington	11	22.0	353,035	32,094	9.9	19	38.0	71,092	3,742	2.0	50	3,572,815	71,456
West Virginia	258	34.2	7,808,005	30,264	13.1	101	13.4	390,689	3,868	.6	755	59,753,701	79,144
Wyoming	15	21.7	511,737	34,116	7.6	16	23.2	48,734	3,046	.7	69	6,742,397	97,716
Total bituminous	1,593	27.1	43,203,932	27,121	10.7	2,077	35.3	6,970,435	3,356	1.7	5,887	404,725,666	68,749
Pennsylvania anthracite	27	9.3	782,856	28,995	.9	26	8.9	111,498	4,288	.1	292	85,725,693	293,581
Grand total	1,620	26.2	43,986,788	27,152	9.0	2,103	34.0	7,081,933	3,368	1.4	6,179	490,451,359	79,374

KINDS OF COAL PRODUCED IN THE UNITED STATES.

In the general discussion of the coal production of the United States only two divisions are considered, anthracite and bituminous, the latter product including the small anthracite output of Colorado and New Mexico. In the bituminous production, however, in addition to the small Rocky Mountain output of anthracite, is also included the production of coals generally classed as semianthracite, semibituminous, cannel, block, splint, and lignite or subbituminous. In the following table the production of these varieties of coal in 1911 is reported as prepared from the schedules returned to the Survey. It should be stated, however, that this classification makes no claim to technical exactness. It has been compiled from the replies of the producers to the inquiry concerning the "Kind of coal produced" on the schedules, and such replies are in some minor cases based on quite uncertain knowledge. It is believed, however, that in this classification the quantity of each kind of coal produced is approximately indicated. It is sufficiently correct for practical purposes and shows that in addition to the production of anthracite in Pennsylvania there were 64,389 short tons produced in Colorado and 34,172 tons in New Mexico. The principal production of semianthracite is in Arkansas, with smaller quantities in Oklahoma and Virginia. The production of Sullivan County, Pa., is included with the anthracite production of that State, though its classification is a matter of some contention. West Virginia leads in the production of semibituminous coal, with Pennsylvania second and Maryland third. West Virginia and Kentucky are credited with the total production of splint coal, and the output of block coal is chiefly from Indiana. The small production of cannel coal is divided among six States, with Kentucky yielding over 50 per cent of the total. Wyoming leads in the production of subbituminous coal, or "black lignite," with Colorado second and Montana third. Texas and North Dakota are the principal producers of true lignite, or "brown coal," all of the latter's production being of that variety.

Classification of the coal product of the United States in 1911, by States, in short tons.

State	Bituminous.	Anthracite.	Semibituminous.	Lignite and subbituminous.	Semianthracite.	Block.	Splint.	Cannel.	Total.
Pennsylvania	139,728,230	90,464,067	4,986,054					39,879	235,218,230
West Virginia	49,613,340		5,574,281			42,652	4,587,057	14,250	59,831,580
Illinois	53,679,118								53,679,118
Ohio	30,754,303							5,683	30,759,986
Alabama	15,021,421								15,021,421
Indiana	13,761,620					*a* 427,860		11,875	14,201,355
Kentucky	12,278,359		112,526			24,600	1,201,079	90,275	13,706,839
Colorado	6,680,257	64,389	1,950,476	1,462,261					10,157,383
Iowa	7,315,058					16,590			7,331,648
Virginia	6,856,205				8,462				6,864,667
Wyoming	455,564		2,933,068	3,356,232					6,744,864
Tennessee	6,425,108							8,048	6,433,156
Kansas	6,254,228								6,254,228
Maryland	1,422,900		3,262,895						4,685,795
Missouri	3,698,607					62,000			3,760,607
Washington	2,890,267		246,371	436,177					3,572,815
New Mexico	2,382,621	34,172		731,365					3,148,158
Oklahoma	2,983,232		65,554		25,456				3,074,242
Montana	664,668		1,418,775	892,915					2,976,358
Utah	2,356,193			156,982					2,513,175
Arkansas	1,809,004				297,785				2,106,789
Texas	1,051,858		32,094	890,641					1,974,593
Michigan	1,476,074								1,476,074
North Dakota				502,628					502,628
Georgia	165,210								165,210
Oregon	6,000		30,365	10,296					46,661
California	1,000			9,747					10,747
Idaho				1,805					1,805
Alaska	600			300					900
North Carolina	120								120
Nevada				16					16
Total	369,731,165	90,562,628	20,612,459	8,451,365	331,703	573,702	5,788,136	170,010	496,221,168

a Includes 25,692 tons of semiblock coal.

LABOR STATISTICS.

The total number of men employed in the coal mines of the United States in 1911 was 722,335, of whom 172,585 were employed in the anthracite mines of Pennsylvania and 549,750 in the bituminous and lignite mines. In 1910 there were 725,030 men employed, 169,497 in the anthracite mines and 555,533 in the bituminous and lignite mines. The anthracite miners averaged 35 days more in working time in 1911 than the bituminous miners, the average in the anthracite mines being 246 days and in the bituminous 211 days. The average number of days worked for all mine workers was 220. Among the more important coal-producing States the average number of days worked ranged from 133 in Arkansas to 261 in Virginia.

The average production for each man employed was 524 tons in the anthracite mines—an exceptionally large tonnage—and 738 tons in the bituminous mines. The average daily production for each man employed was 2.13 short tons in the anthracite and 3.50 tons in the bituminous mines.

The following table shows the number of men employed in the coal mines of the United States in 1906, 1907, 1908, 1910, and 1911, with the average number of days worked by States. The statistics of labor in 1909 were collected by the Bureau of the Census, and the inquiries were in such form that the compilations did not give results comparable with the statistics presented in these reports:

Statistics of labor employed in coal mines of the United States, 1906–1911, by States.

State.	1906		1907		1908		1910		1911	
	Number of days active.	Average number employed.	Number of days active.	Average number employed.	Number of days active.	Average number employed.	Number of days active.	Average number employed.	Number of days active.	Average number employed.
Alabama	237	20,555	242	21,388	222	19,197	249	22,210	227	22,707
Arkansas	165	4,298	190	5,085	145	5,337	128	5,568	133	5,657
California	[a] 253	[a] 56	[a] 187	[a] 76	[a] 220	[a] 49	189	19	[a] 265	[a] 60
Colorado	268	11,368	258	14,223	212	14,523	236	15,864	207	14,316
Georgia	279	737	262	808	261	670	265	386	[b] 277	[b] 514
Idaho	[c] 157	[c] 25	[d] 121	[d] 22	160	24	200	14	[c] 228	[c] 13
Illinois	192	61,988	218	65,581	185	68,035	160	72,645	188	76,600
Indiana	175	20,970	197	21,022	174	18,380	229	21,878	182	21,182
Iowa	224	15,260	230	15,585	214	16,021	218	16,666	203	16,599
Kansas	165	14,355	225	12,439	181	13,916	148	12,870	189	11,625
Kentucky	212	15,272	210	16,971	186	16,996	221	20,316	191	21,821
Maryland	250	6,438	263	5,880	220	6,079	270	5,809	243	5,881
Michigan	173	3,971	234	3,982	207	4,247	211	3,575	218	3,323
Missouri	185	9,557	214	8,448	169	8,988	154	9,691	183	9,991
Montana	243	2,394	268	2,735	224	3,146	239	3,837	220	3,866
New Mexico	242	2,070	269	2,970	197	3,448	283	3,585	230	4,007
North Dakota	209	488	223	562	181	631	207	534	229	640
Ohio	167	45,438	199	46,833	161	47,407	203	46,641	179	46,035
Oklahoma (Indian Territory)	166	8,251	216	8,398	172	8,651	144	8,657	156	8,790
Oregon	224	209	231	184	249	214	257	153	179	189
Pennsylvania bituminous	231	152,099	255	163,295	201	165,961	238	175,403	233	168,274
Tennessee	229	11,452	232	12,052	209	11,812	225	11,930	232	10,703
Texas	227	3,048	242	4,227	254	4,400	234	4,197	226	5,353
Utah	288	1,572	258	2,203	227	2,664	260	3,053	236	3,060
Virginia	250	5,131	241	6,670	200	6,208	241	7,264	261	7,392
Washington	266	4,529	273	5,945	202	5,484	256	6,314	225	6,498
West Virginia	220	50,960	230	59,029	185	56,861	228	68,663	221	66,730
Wyoming	281	5,934	275	6,645	217	6,915	248	7,771	230	7,924
Total bituminous	213	478.425	234	513,258	193	516,264	217	555,533	211	549,750
Pennsylvania anthacite	195	162,355	220	167,234	200	174,174	229	169,497	246	172,585
Grand total	209	640,780	231	680,492	195	690,438	220	725,030	220	722,335

[a] Includes Alaska.
[b] Includes North Carolina.
[c] Includes Nevada.
[d] Includes Nebraska and Nevada.

In the following table is presented a statement of the number of men employed in the anthracite and bituminous mines, the average number of days worked, and the average production per man, per day and per year, annually since 1890, except, for reasons stated, for 1909. The notable feature of this statement is the marked increase in the average tonnage, both per day and per year, by the bituminous coal miners, the average daily production in 1911 being the largest during this period—nearly 1 ton, or practically 40 per cent, more than in 1890. There has also been an increase in the average yearly tonnage per man in the anthracite region, principally during the last few years, although the average daily tonnage has not shown any such marked increase and during the last decade has shown a declining tendency. The increased yearly tonnage per man in the anthracite mines has been due to the policy of the operators, adopted within the last decade, of allowing discounts from the circular prices during the spring and summer months with the idea of encouraging consumers to make their cellars the storage places for the winter supply of fuel. It will be observed that in the five years from 1897 to 1901, inclusive, the average working time in the anthracite region ranged from 150 to 196 days, with a mean average of 167. In the five years from 1906 to 1911, inclusive (leaving out 1909), the average time has ranged from 195 to 246 days and with a mean average of 218 days. The shortest year (1906) in the latter period was only a day less than the longest year of the earlier period. The difference in the mean averages of the two periods was 51 days, or 30 per cent in favor of the latter. The average number of days in the bituminous region has not shown the same increase—in fact, the tendency has been in the other direction. The average working time in the bituminous mines from 1897 to 1901 ranged from 196 days to 234 days, with a mean average of 220 days. In the latter period the average time of the bituminous miners ranged from 193 to 234 days, with a mean average of 214. The increased production per man in the bituminous mines has been due to the increased use of mining machinery. In 1891, the first year for which the statistics of machine-mined coal have been given, this factor represented only a little more than 5 per cent of the total output and the average production per man was 2.57 short tons for each working day and 573 tons for the year. In 1911 of the total production of bituminous coal 43.09 per cent was machine-mined, and the average production for each employee was 3.5 tons for each day and 738 tons for the year.

Production of coal according to number of persons employed, 1890–1911.

Year.	Anthracite.				Bituminous.			
	Men employed.	Days worked.	Average tonnage per man per day.	Average tonnage per man per year.	Men employed.	Days worked.	Average tonnage per man per day.	Average tonnage per man per year.
1890	126,000	200	1.85	369	192,204	226	2.56	579
1891	126,350	203	1.98	401	205,803	223	2.57	573
1892	129,050	198	2.06	407	212,893	219	2.72	596
1893	132,944	197	2.06	406	230,365	204	2.73	557
1894	131,603	190	2.08	395	244,603	171	2.84	486
1895	142,917	196	2.07	406	239,962	194	2.90	563
1896	148,991	174	2.10	365	244,171	192	2.94	564
1897	149,884	150	2.34	351	247,817	196	3.04	596
1898	145,504	152	2.41	367	255,717	211	3.09	651
1899	139,608	173	2.50	433	271,027	234	3.05	713
1900	144,206	166	2.40	398	304,375	234	2.98	697
1901	145,309	196	2.37	464	340,235	225	2.94	664
1902	148,141	116	2.40	279	370,056	230	3.06	703
1903	150,483	206	2.41	496	415,777	225	3.02	680
1904	155,861	200	2.35	469	437,832	202	3.15	637
1905	165,406	215	2.18	470	460,629	211	3.24	684
1906	162,355	195	2.25	439	478,425	213	3.36	717
1907	167,234	220	2.33	512	513,258	234	3.29	769
1908	174,174	200	2.39	478	516,264	193	3.34	644
1910	169,497	229	2.17	498	555,533	217	3.46	751
1911	172,585	246	2.13	524	549,750	211	3.50	738

In most of the bituminous mines of the United States the 8-hour working day prevails. In 1911, out of a total of 549,750 employees in the bituminous coal mines, 330,045 worked in mines that were operated 8 hours a day; 57,351 worked in mines that were operated 9 hours a day, and 137,576 worked in mines operated 10 hours a day. The mines which did not report the number of hours to the working day in 1911 employed a total of 24,191 men. It must be remembered, however, that when the length of the working day is stated reference is made to the time the mines are supposed to be in operation, not to the number of hours worked by the miners. In both the anthracite and the bituminous fields practically all the coal is mined by contract at so much per ton, per mine car, by yardage, or on other basis of payment, and the miner being an independent contractor is not obliged to put in a certain number of hours at his working place. Since the settlement of the great strike of 1902 the anthracite mines of Pennsylvania have been operated on a 9-hour basis, with the exception of engineers and pumpmen, who work 8 hours, and, of course, the miners who work by contract. In the bituminous fields the 8-hour day prevails in the States where the men are well organized, and in the districts where the mines are "open shop" or nonunion the 9 or 10 hour day is usual.

The important bituminous coal-producing States in which the 8-hour day is generally observed are Arkansas, Illinois, Indiana, Iowa, Kansas, Michigan, Missouri, Montana, Ohio, Oklahoma, Pennsylvania, Texas, Utah, Washington, and Wyoming. It will be noted in the following table that this list includes all of the States of the Mississippi Valley region, two—Ohio and Pennsylvania—in the Appalachian region, and three—Montana, Utah, and Wyoming—in the Rocky Mountain region. In two of the Rocky Mountain States—Colorado and New Mexico—the 10-hour day prevails, and this is also the case in the Southern States of Alabama, Kentucky, Maryland, Virginia, and West Virginia. In Tennessee the majority of the mines are worked 9 hours a day.

Number of hours to the working day, by States.

1910.

State.	8 hours.		9 hours.		10 hours.		All others.
	Mines.	Men.	Mines.	Men.	Mines.	Men.	Men.
Alabama	18	766	36	2,633	134	17,306	1,505
Arkansas	63	5,312					256
Colorado	61	2,935	8	303	49	5,913	6,713
Illinois	521	69,575	7	137	1	4	2,929
Indiana	215	20,783	4	16	3	14	1,065
Iowa	229	16,238	2	10	3	11	407
Kansas	126	12,255	9	115	1	5	495
Kentucky	69	6,095	56	3,965	126	9,064	1,192
Maryland	3	9	6	71	61	5,717	12
Michigan	27	3,511					64
Missouri	166	9,027	10	100	1	17	547
Montana	44	3,568			1	6	263
New Mexico	5	21	5	185	16	3,345	34
North Dakota	11	94	6	75	16	327	38
Ohio	587	45,001	12	249	1	5	1,386
Oklahoma	89	8,472			2	50	135
Oregon	6	150			1	1	2
Pennsylvania	834	101,208	272	30,270	225	37,769	6,156
Tennessee	5	451	86	7,566	32	3,395	518
Texas	20	2,302	1	70	17	1,536	289
Utah	20	3,049					4
Virginia	1	189	10	1,021	45	5,710	344
Washington	40	6,129					185
West Virginia	49	4,671	133	12,950	494	50,432	610
Wyoming	41	6,175					1,596
Total	3,250	327,986	663	59,756	1,229	140,627	26,745

1911.

State.	8 hours.		9 hours.		10 hours.		All others.
	Mines.	Men.	Mines.	Men.	Mines.	Men.	Men.
Alabama	15	550	50	5,345	102	12,628	4,184
Arkansas	53	5,196					461
Colorado	57	2,701	10	299	46	4,559	6,757
Illinois	513	75,088	9	68	2	10	1,434
Indiana	213	20,946	2	7	3	16	213
Iowa	196	16,095	3	16			488
Kansas	122	11,257	7	177			191
Kentucky	79	6,103	46	4,789	143	10,189	740
Maryland	2	8	9	148	59	5,670	55
Michigan	21	3,274					49
Missouri	192	9,702	8	84			205
Montana	44	3,862					4
New Mexico	2	5	6	167	22	3,823	12
North Dakota	12	115	4	46	24	423	56
Ohio	566	44,351	7	378	3	8	1,298
Oklahoma	90	8,247			3	35	508
Oregon	6	87			1	2	100
Pennsylvania	842	99,522	273	28,204	214	37,661	2,887
Tennessee	6	375	56	5,929	30	3,978	421
Texas	16	3,007	3	179	18	1,649	518
Utah	21	3,056					4
Virginia	2	43	4	33	52	6,929	387
Washington	45	5,642					856
West Virginia	49	4,242	126	11,477	527	49,996	1,015
Wyoming	60	6,571	2	5			1,348
Total	3,224	330,045	625	57,351	1,249	137,576	24,191

There are so many influences affecting the production of coal in the several States that it is not possible to draw any reliable conclusions in regard to the effect of the length of the working day upon the productive efficiency of the labor. Principal among these is the independent character of the miner himself, for whom no time record is kept. The thickness of the coal beds and the character of the coal are potential influences upon the capacity of the miner, and these vary over such wide ranges even in one State that any deductions drawn from the statistics herewith presented would be misleading and valueless. The following table shows the prevailing number of hours to the day in the more important coal-producing States, the number of days worked in each, and the average tonnage made by each employee per day for the year, in 1908, 1910, and 1911. The largest average yearly tonnage—929 tons—per man in 1911 was made by Virginia, a 10-hour per day State. The second largest tonnage per man was made in West Virginia, where most of the mines are worked 10 hours and some are worked 9. The third largest tonnage was made in Pennsylvania bituminous mines—860 tons—where most of the mines are worked 8 hours per day. The fourth largest production—851 tons—was made in Wyoming, where nearly all of the mines are worked 8 hours per day. The smallest average—350 tons—was made in Oklahoma, an 8-hour per day State, and next to the lowest was made in Arkansas—372 tons—also an 8-hour per day State, but it is well known that mining conditions in both Oklahoma and Arkansas are not nearly so favorable as in most of the other coal-producing States. The average production per man in 1911 in the States where the 8-hour day prevails was 601 tons and in the States in which the 9-hour and 10-hour day prevails it was 769 tons. The best average daily production per man in 1911 was in West Virginia where the 10-hour day prevails. In 1910 the best daily record was made in Illinois where the 8-hour day prevails. The lowest daily tonnages in 1911 were made in Michigan and Missouri, both 8-hour day States, but in both these States the beds are thin and mining difficult as compared with other States.

In 1911 the mean average number of days worked in the mines operating 8 hours a day was 226.5, and in the States where the 9-hour and 10-hour day prevails the average number of days worked was 198.

Average production per man compared with hours worked per day, and average number of days per year in 1908, 1910, and 1911.

State.	1908				1910				1911			
	Number of hours per day.	Days worked.	Average tonnage.		Number of hours per day.	Days worked.	Average tonnage.		Number of hours per day.	Days worked.	Average tonnage.	
			Per year.	Per day.			Per year.	Per day.			Per year.	Per day.
Alabama	9 and 10	222	604.5	2.72	9 and 10	249	725	2.91	9 and 10	227	662	2.92
Arkansas	8	145	389.4	2.68	8	128	342	2.67	8	133	372	2.80
Colorado	8 and 10	212	663.4	3.13	8 and 10	236	755	3.20	8 and 10	207	710	3.42
Illinois	8	185	700.5	3.79	8	160	632	3.95	8	188	701	3.73
Indiana	8	174	670.0	3.85	8	229	841	3.67	8	182	670	3.68
Iowa	8	214	447.0	2.09	8	218	476	2.18	8	203	442	2.18
Kansas	8	181	448.8	2.48	8	148	382	2.58	8	189	538	2.85
Kentucky	8, 9, and 10	186	602.9	3.24	8, 9, and 10	221	720	3.26	8, 9, and 10	191	628	3.29
Maryland	10	220	720.0	3.27	10	270	898	3.33	10	243	797	3.21
Michigan	8	207	432.1	2.09	8	211	429	2.03	8	218	444	2.04
Missouri	8	169	369.1	2.18	8	154	308	2.00	8	183	376	2.05
Montana	8	224	610.4	2.73	8	239	762	3.19	8	220	770	3.50
New Mexico	10	197	715.8	3.63	10	283	979	3.46	10	230	788	3.41
Ohio	8	161	554.2	3.44	8	203	733	3.61	8	179	668	3.73
Oklahoma	8	172	340.8	1.98	8	144	306	2.13	8	156	350	2.24
Pennsylvania:												
Anthracite	9	200	478.1	2.39	9	229	498	2.17	9	246	524	2.13
Bituminous	[a] 8	201	706.1	3.51	[a] 8	238	858	3.61	[a] 8	233	860	3.69
Tennessee	9 and 10	209	524 8	2.51	9 and 10	225	597	2.65	9 and 10	232	601	2.59
Utah	8	227	693.2	3.05	8	260	825	3.17	8	236	821	3.48
Virginia	10	200	686.1	3.43	10	241	896	3.72	10	261	929	3.56
Washington	8	202	551.6	2.73	8	256	620	2.42	8	225	550	2.44
West Virginia	9 and 10	185	736.8	3.98	9 and 10	228	898	3.94	9 and 10	221	896	4.05
Wyoming	8	217	793.9	3.66	8	248	969	3.91	8	230	851	3.70

[a] Represents 60 per cent of employees; the other 40 per cent about evenly divided between 9 and 10 hours.

LABOR TROUBLES.

So far as the time lost by reason of strikes or other labor disaffections is concerned, 1911 was an off year. The biennial agreements in the organized States are from April 1 of an "even" year to March 31 of the second year. For this reason there was not in 1911 any wide-spread or prolonged idleness because of labor troubles. There were, as there always will be, some local difficulties, but these were in most cases of short duration and did not affect the production for the year. The most extended difficulty was in the Boulder region of Colorado, where 150 men were idle for 216 days. In Missouri 504 men were idle for an average of 48 days, and in Ohio, 9,530 men were idle for an average of 37 days. These instances represent the principal interruptions to work during the year by labor troubles. The total number of men idle throughout the year was 41,413. Of these, 35,513 were in the bituminous mines and the average time lost by them was 27 days. The total number of working days lost was less than 983,737, whereas in 1910 there were 215,640 men idle in the bituminous mines alone, and the average time lost by each man was 89 days, with a total loss of 19,234,785 working days. The labor troubles in the anthracite region of Pennsylvania affected a total of 5,900 men and the average time lost by each was 6 days. The humor of the situation in the anthracite mines in 1911 is shown in the fact that at one time 48 boys and at another 56 boys were on strike, and these threw 1,130 and 1,235 men, respectively, out of work, the former for 4½ and the latter for 2 days.

The statistics of labor troubles in 1910 and 1911 are presented in the following table:

Statistics of labor strikes in the coal mines of the United States in 1910 and 1911.

State.	1910.			1911.		
	Number of men on strike.	Total days lost.	Average number of days lost per man.	Number of men on strike.	Total days lost.	Average number of days lost per man.
Alabama	25	1,250	50	210	1,260	6
Arkansas	4,873	713,210	146	665	4,615	7
Colorado	2,044	195,558	96	150	32,375	216
Georgia	270	2,970	11	....	....	....
Illinois	67,218	9,133,953	136	5,543	100,588	18
Indiana	12,638	423,894	34	4,577	146,636	32
Iowa	9,209	408,563	44	1,622	31,870	20
Kansas	10,346	1,578,027	153	984	8,507	9
Kentucky	1,475	15,197	10	1,080	34,008	32
Michigan	1,663	86,789	52	....	....	....
Missouri	7,774	1,218,599	157	504	24,216	48
Montana	345	38,260	111	529	8,114	15
North Dakota	....	....	....	34	69	2
Ohio	24,746	1,334,631	54	9,530	350,039	37
Oklahoma	8,213	1,247,828	152	444	15,106	34
Pennsylvania	60,098	2,700,746	45	5,601	148,124	26
Tennessee	....	....	....	163	1,630	10
Texas	1,776	108,230	61	60	300	5
Utah	....	....	....	208	624	3
Washington	101	303	3	2,099	22,215	10
West Virginia	1,630	13,985	9	1,510	16,483	11
Wyoming	1,196	12,792	11	....	....	....
Total bituminous	215,640	19,234,785	89	35,513	946,779	27
Pennsylvania anthracite	2,853	15,739	6	5,900	36,958	6

A summary of the statistics of strikes in the coal mines of the United States since 1899 is given in the following table:

Summary of labor strikes in the coal mines of the United States, 1899–1911.

Years.	Number of men on strike.	Total working days lost.	Average number of days lost per man.
1899	45,981	2,124,154	46
1900	131,973	4,878,102	37
1901 [a]	20,593	733,802	35
1902	200,452	16,672,217	83
1903 [a]	47,481	1,341,031	28
1904	77,661	3,382,830	44
1905	37,542	796,735	21
1906	372,343	19,201,348	51.5
1907 [a]	32,540	462,392	14
1908 [a]	145,145	5,449,938	38
1909 [a]	24,763	723,634	29
1910	218,493	19,250,524	88
1911	41,413	983,737	24

[a] Bituminous mines only.

COAL MINED BY MACHINES.

The total production of bituminous coal in the United States decreased from 417,111,142 short tons in 1910 to 405,757,101 short tons in 1911, but the quantity of coal undercut or otherwise mined by the use of machines increased from 174,012,293 short tons to 177,971,976 tons. The decrease in the total production was 11,354,041 short tons, whereas the increase in the production of machine-mined coal was 3,959,683 tons. The percentage of the machine-mined tonnage to the total output increased from 41.74 in 1910 to 43.89 in 1911. The progress made in recent years in the substitution of mechanical methods in the mining of bituminous coal has been one of the most interesting developments in the history of the industry. It is true that in many cases this substitution has been a matter of necessity, brought about by the increased cost of mine labor coupled with increased competition which prohibited any material advance in the selling prices. As has been stated in the previous reports of this series, and as is well known by those familiar with the bituminous coal mining industry of the United States, the mines at present developed are capable of producing, with a plentiful supply of labor and ample transportation facilities, from 50 to 75 per cent more than the high record of 1911 and even higher record of 1910. It is probably not an exaggeration to state that the bituminous mines of the United States are capable of producing from 600,000,000 to 700,000,000 short tons of coal without opening another new mine. This condition of capacity in excess of demand has existed for at least a quarter of a century, in spite of which owners of coal lands are constantly inspired to have them developed and this spirit has certainly not been discouraged by the railroad companies, which, in order to secure control of new tonnage and to get the benefit of low-priced coal for their own consumption, are constantly building into new territory and adding new production to an already crowded market. The newer mines are naturally capable of producing coal more cheaply and of securing a better complement of men.

In order to meet these conditions and also to meet the general tendency toward increased cost of labor, operators have been impelled to the utilization of labor-saving and expense-reducing machinery, but the change has not always been easily accomplished, and in some States to-day the differentials in mining rates against the machines destroy, or materially reduce, the advantages in cheapness of production sought to be gained. In addition to the lessening of the mining cost, however, there are two other aims to be accomplished in the use of mining machines. The undercutting of coal by hand is one of the most exacting kinds of labor, and the use of machinery materially mitigates the arduous character of the miner's employment. More important than this, however, is the greater safety secured through reducing the practice, too prevalent in many mining districts, of shooting from the solid. This practice can not be too strongly condemned, for it increases the liability to accident and is contrary to conservation, in that it produces an inordinate quantity of undesirable or unmarketable fuel. It is gratifying to note, therefore, the steady increase in the proportion of coal mined by the use of machines, for it indicates, though it does not actually prove, a larger proportion of coal undercut before being shot down. Recent developments in mining machinery, as mentioned in the report for 1909, have been in the bringing out by several different manufacturers of a type of machine for undercutting or shearing the coal or cutting out clay bands in steeply inclined beds. This new type of cutter is practically the punching machine mounted on a post and radially actuated. Another new type of machine is the "short-wall" or "continuous cutter," which is in reality the application of the principle of the long-wall machine to the pillar and room system of mining. These machines move along the face of the coal, cutting as they go and do not have to be withdrawn the width of the cutting frame after each cut, as with the chain-breast machine.

The number of machines reported in the coal mines of the United States in 1911 was 13,819, an increase of 565 over 1910, when the number of machines in use was reported at 13,254. The average number of tons mined by each machine in 1911 was 12,879, compared with 13,127 in 1910. Of the 13,819 machines in use in 1911, 6,535 were pick or puncher machines, 5,943 were chain-breast, 481 were long-wall, 777 were short-wall or continuous cutters, and 83 were of the radialaxe or post-puncher type. As the leading coal-producing State, Pennsylvania also is first in the total tonnage mined by the use of machines and in the total number of machines in use, but in the proportion of machine-mined coal to the total output Ohio far outranks all other States. In 1911 Pennsylvania's production of machine-mined coal was 69,131,923 short tons, or 47.76 per cent of the total. Ohio's production of machine-mined coal was 26,556,630 tons, or 86.33 per cent of the total. Ohio is third in the production of machine-mined coal though ranking fourth in the total production. West Virginia, the second State in coal production, is also second in the output of machine-mined coal, the machine-mined output in 1911 being 29,121,480 short tons, or 48.67 per cent of the total. Illinois is fourth in the quantity of machine-mined coal, with 23,093,807 short tons.

The statistics in regard to the coal mined by machines during the last five years are shown in the following table, together with the number of machines used in each State, the number of tons mined by machines, the total production of the States in which machines were used, and the percentage of the machine-mined product to the total of those States.

Bituminous coal mined by machines in the United States, 1907–1911, by States.

State.	Number of machines in use.					Number of tons mined by machines.				
	1907	1908	1909	1910	1911	1907	1908	1909	1910	1911
Alabama	197	197	283	317	272	1,762,948	1,783,516	2,203,619	2,980,122	2,936,512
Arkansas				12	14				13,383	27,029
Colorado	175	211	253	256	242	1,689,517	1,668,602	1,929,545	1,905,781	1,975,411
Illinois	1,080	1,217	1,260	1,361	1,402	15,134,401	15,045,004	17,488,427	17,730,298	23,093,807
Indiana	513	507	631	645	667	5,310,607	5,294,092	7,408,829	8,986,495	7,049,758
Iowa	33	28	5	17	20	108,022	71,463	7,500	22,158	42,963
Kansas	6	17	16	13	15	35,317	133,248	59,976	34,240	100,444
Kentucky	708	759	877	899	977	5,504,262	5,252,753	6,461,593	9,362,851	9,002,288
Maryland	43	39	39	38	37	479,110	208,134	117,568	137,216	154,301
Michigan	103	120	101	100	113	606,718	535,543	511,895	698,191	734,246
Missouri	62	57	96	96	92	486,882	479,850	796,438	553,656	753,614
Montana	86	57	81	99	87	984,368	713,217	840,686	866,461	1,172,582
New Mexico	3	7	4	3	10	11,615	30,600	1,352	71,609	93,722
North Dakota	12	11	16	13	11	136,700	104,884	112,365	165,366	192,943
Ohio	1,328	1,343	1,433	1,452	1,536	24,843,616	19,799,140	22,148,216	28,887,241	26,556,630
Oklahoma (Indian Territory)	11	17	34	13	26	24,331	31,352	50,812	28,166	87,048
Pennsylvania	4,940	5,103	5,616	5,505	5,719	60,771,157	52,447,809	57,504,188	68,501,041	69,131,923
Tennessee	137	122	197	178	179	874,925	787,502	1,040,798	1,226,672	914,614
Texas	13	6	11	14	15	36,100	15,000	17,230	20,360	71,085
Utah	5			7	7	1,800			24,000	70,653
Virginia	77	85	107	142	156	788,793	1,035,832	1,323,111	2,290,435	2,551,627
Washington		4	18	10	23		20,000	48,690	56,000	188,707
West Virginia	1,533	1,574	1,844	1,966	2,044	17,627,925	16,653,174	20,993,489	27,981,617	29,121,480
Wyoming	79	88	127	98	155	1,328,769	1,072,619	1,430,551	1,468,994	1,948,589
Total	11,144	11,569	13,049	13,254	13,819	138,547,823	123,183,334	142,496,878	174,012,293	177,971,976

State.	Total tonnage of States using mining machinery.					Percentage of total product mined by machines.				
	1907	1908	1909	1910	1911	1907	1908	1909	1910	1911
Alabama	14,250,454	11,604,593	13,703,450	16,111,462	15,021,421	12.37	15.37	15.02	18.50	19.55
Arkansas				1,905,958	2,106,789				.70	1.28
Colorado	10,790,236	9,634,973	10,716,936	11,973,736	10,157,383	15.66	17.32	18.00	15.99	19.45
Illinois	51,317,146	47,659,690	50,904,990	45,900,246	53,679,118	29.49	31.57	34.00	38.63	43.02
Indiana	13,985,713	12,314,890	14,834,259	18,389,815	14,201,355	37.97	42.99	50.00	48.87	49.64
Iowa	7,574,322	7,161,310	7,757,762	7,928,120	7,331,648	1.43	1.00	.10	.28	.59
Kansas	7,322,449	6,245,508	6,986,478	4,921,451	6,254,228	.48	2.13	.85	.70	1.61
Kentucky	10,753,124	10,246,553	10,697,384	14,623,319	13,706,839	51.19	51.27	60.50	64.03	65.68
Maryland	5,532,628	4,377,093	4,023,241	5,217,125	4,685,795	8.66	4.76	2.90	2.63	3.29
Michigan	2,035,858	1,835,019	1,784,692	1,534,967	1,476,074	29.80	29.18	28.70	45.49	49.74
Missouri	3,997,936	3,317,315	3,756,530	2,982,433	3,760,607	12.18	14.47	21.20	18.56	20.04
Montana	2,016,857	1,920,190	2,553,940	2,920,970	2,976,358	48.81	37.14	32.90	29.66	39.40
New Mexico	2,628,959	2,467,937	2,801,128	3,508,321	3,148,158	.44	1.24		2.04	2.98
North Dakota	347,760	320,742	422,047	399,041	502,628	39.31	32.70	27.26	41.44	38.39
Ohio	32,142,419	26,270,639	27,939,641	34,209,668	30,759,986	77.29	75.37	79.50	84.44	86.33
Oklahoma (Indian Territory)	3,642,658	2,948,116	3,119,377	2,646,226	3,074,242	.67	1.06	1.50	1.06	2.83
Pennsylvania	150,143,177	117,179,527	137,906,791	150,521,526	144,754,163	40.48	44.76	41.68	45.51	47.76
Tennessee	6,810,243	6,199,171	6,358,645	7,121,380	6,433,156	12.85	12.70	16.40	17.23	14.22
Texas	1,648,069	1,895,377	1,824,440	1,892,176	1,974,593	2.19	.79	.94	1.08	3.60
Utah	1,947,607			2,517,809	2,513,175	.09			.95	2.81
Virginia	4,710,895	4,259,042	4,752,217	6,507,997	6,864,667	16.74	24.32	27.88	35.19	37.17
Washington		3,024,943	3,602,263	3,911,899	3,572,815		.66	1.35	1.43	5.28
West Virginia	48,091,583	41,897,843	51,849,220	61,671,019	59,831,580	36.65	39.75	40.80	45.37	48.67
Wyoming	6,252,990	5,489,902	6,393,109	7,533,088	6,744,864	21.25	19.54	22.38	19.50	28.89
Total	387,943,083	328,270,373	374,688,540	416,849,752	405,531,642	[a] 35.71	[a] 37.52	[a] 38.03	[a] 41.74	[a] 43.89

[a] Average.

One of the determining factors in the choice of machines for undercutting the coal is the character of the roof, it being impracticable to operate chain-breast machines when the roof is tender and the timbering has to be kept up close to the face. This limitation does not apply to the short-wall or continuous-cutter machines, which can be operated in mines where the timbering is within 3 feet, or even less, of the face. Neither of these machines is so well adapted as the punchers for use in mines where "sulphur balls" (nodules of iron pyrites) are prevalent, as the sulphur balls will break or quickly dull the cutting bits, whereas the operator of the puncher can cut around them. The limitations of the chain type of machine (including the continuous cutters) are compensated for, however, by the higher efficiency in the mines where they can be used and by the greater ease with which the wires can be carried through the mines as compared with the air pipes for the punchers. Most of the chain machines are operated by electricity, and compressed air is used to actuate the punchers. It will be observed from the following table that in Ohio where the machine production represents all but 15 per cent of the total, chain-breast machines are largely in the ascendant, while in Pennsylvania, where the largest tonnage is produced, the pick or puncher machines nearly double the number of chain machines. Among the other more important States pick machines are more numerous than the chain machines in Alabama, Colorado, Illinois, Kentucky, and Tennessee, and the chain machines appear to be the more popular in Indiana, Virginia, and West Virginia. Missouri is the only State in which long-wall machines are the more numerous. The radialaxe, or post-puncher machine, was intended principally to furnish a machine capable of cutting the coal in beds too steeply inclined for the puncher, chain-breast, or long-wall machines. The largest number of these machines in use is in Washington, where the beds are much inclined and distorted. Colorado, Oklahoma, and Wyoming were also prominent in the installation of this type of machine, which appears to meet some of the conditions in those States.

In the following table are shown the number and kind of machines in use in each State, so far as they were reported to the survey in 1910 and 1911:

Number and kinds of machines in use in 1910 and 1911, by States.

State.	1910					1911					
	Pick.	Chain breast.	Long-wall.	Short-wall.	Total.	Pick.	Chain breast.	Long-wall.	Short-wall.	Radial-axe or post.	Total.
Alabama	215	82	20	....	317	184	53	13	22	....	272
Arkansas	6	6	....	....	12	....	10	....	2	2	14
Colorado	182	55	19	....	256	157	26	34	17	8	242
Illinois	816	543	2	....	1,361	780	555	20	47	....	1,402
Indiana	194	422	29	....	645	166	426	30	45	....	667
Iowa	11	6	....	....	17	10	6	3	....	1	20
Kansas	11	2	....	....	13	15	....	....	....	....	15
Kentucky	536	325	37	1	899	544	309	72	52	....	977
Maryland	37	....	1	....	38	29	....	1	6	1	37
Michigan	51	42	4	3	100	60	46	....	7	....	113
Missouri	23	....	73	....	96	17	....	75	....	....	92
Montana	65	32	1	1	99	56	18	....	11	2	87
New Mexico	....	2	1	....	3	4	4	2	....	....	10
North Dakota	4	9	....	....	13	....	11	....	....	....	11
Ohio	104	1,319	24	5	1,452	92	1,343	54	47	....	1,536
Oklahoma	12	....	1	....	13	5	6	5	2	8	26
Pennsylvania	3,534	1,872	86	13	5,505	3,556	1,874	82	188	19	5,719
Tennessee	131	22	13	12	178	121	15	9	31	3	179
Texas	8	6	....	....	14	12	....	3	....	....	15
Utah	7	....	....	....	7	5	2	....	....	....	7
Virginia	14	118	4	6	142	....	121	....	35	....	156
Washington	10	....	....	....	10	....	....	....	....	23	23
West Virginia	680	1,081	199	6	1,966	667	1,041	77	253	6	2,044
Wyoming	65	29	4	....	98	55	a 77	1	12	10	155
Total	6,716	5,973	518	47	13,254	6,535	5,943	481	777	83	13,819

a Includes 2 cutter-bar machines.

The statistics relating to the use of mining machines were first collected by the Survey for the year 1896. The inquiries at that time covered the number of machines in use and the quantity of coal won by them in 1891, five years before. From the returns to the Survey since 1896, the results of which have been published in detail in the preceding volumes of Mineral Resources of the United States, the following table has been prepared, showing the development in the mechanical mining of bituminous coal since 1891:

Production of coal by machines in the United States since 1891, in short tons.

Year.	Number of machines in use.	Total tonnage won by machines.	Average production for each machine.
1891	545	6,211,732	11,398
1896	1,446	16,424,932	11,373
1897	1,956	22,649,220	11,579
1898	2,622	32,413,144	12,362
1899	3,125	43,963,933	14,068
1900	3,907	52,784,523	13,510
1901	4,341	57,843,335	13,325
1902	5,418	69,611,582	12,848
1903	6,658	77,974,894	11,712
1904	7,663	78,606,997	10,258
1905	9,184	103,396,452	11,258
1906	10,212	118,847,527	11,638
1907	11,144	137,973,701	12,381
1908	11,569	123,183,334	10,648
1909	13,049	142,496,878	10,920
1910	13,254	174,012,293	13,127
1911	13,819	177,971,976	12,879

There are some exceptions to the rule, but it generally appears that in States where the percentage of machine-mined coal has shown marked increase there has also been a notable gain in the efficiency of labor, as indicated by the average daily tonnage for each man employed. It will be noted in the following table that in Ohio where the percentage of machine-mined coal increased from 84.44 in 1910 to 86.33 in 1911, the average production per day per man increased from 3.61 to 3.73. In Pennsylvania the machine-mined percentage increased from 45.51 to 47.76, and the average tonnage per day from 3.61 to 3.69. In West Virginia the percentage of machine-mined coal increased from 45.37 to 48.67, and the daily average production per man from 3.94 to 4.05 tons. Illinois appears as a notable exception to this relationship, for whereas the percentage of machine-mined tonnage in that State increased from 38.63 in 1910 to 43.02 in 1911, the average daily production per man decreased from 3.95 to 3.73. Wyoming also shows an exception, with an increased percentage of machine-mined coal from 19.5 to 28.89, and with a decrease in the average daily tonnage per man per day from 3.9 to 3.7. Tennessee's percentage of machine-mined coal decreased from 17.23 to 14.22, and the average daily tonnage per man from 2.65 to 2.59. In the following table the quantity and percentage of machine-mined production in 1910 and 1911, by States, are compared with the average daily and yearly production for each employee in the States where mining machines are used:

Average production per man compared with production by machines in 1910 and 1911, by States, in short tons.

State.	Average tonnage.				Production by machines.			
	Per year.		Per day.		Total tonnage by machines.		Per cent of machine coal to State total.	
	1910	1911	1910	1911	1910	1911	1910	1911
Alabama	725	662	2.91	2.92	2,980,122	2,936,512	18.50	19.55
Arkansas	342	372	2.67	2.80	13,383	27,029	.70	1.28
Colorado	755	710	3.20	3.42	1,905,781	1,975,411	15.99	19.45
Illinois	632	701	3.95	3.73	17,730,298	23,093,807	38.63	43.02
Indiana	841	670	3.67	3.68	8,986,495	7,049,758	48.87	49.64
Iowa	476	442	2.18	2.18	22,158	42,963	.28	.59
Kansas	382	538	2.58	2.85	34,240	100,444	.70	1.61
Kentucky	720	628	3.26	3.29	9,362,851	9,002,288	64.03	65.68
Maryland	898	797	3.33	3.21	137,216	154,301	2.63	3.29
Michigan	429	444	2.03	2.04	698,191	734,246	45.49	49.74
Missouri	308	376	2.00	2.05	553,656	753,614	18.56	20.04
Montana	762	770	3.19	3.50	866,401	1,172,582	29.66	39.40
New Mexico	979	788	3.46	3.41	71,609	93,722	2.04	2.98
North Dakota	747	785	3.61	3.43	165,366	192,943	41.44	38.39
Ohio	733	668	3.61	3.73	28,887,241	26,556,630	84.44	86.33
Oklahoma	306	250	2.13	2.24	28,166	87,048	1.06	2.83
Pennsylvania, bituminous	858	860	3.61	3.69	68,501,041	69,131,923	45.51	47.76
Tennessee	597	601	2.65	2.59	1,226,672	914,614	17.23	14.22
Texas	451	369	1.93	1.63	20,360	71,085	1.08	3.60
Utah	825	821	3.17	3.48	24,000	70,653	.95	2.81
Virginia	896	929	3.72	3.56	2,290,435	2,551,627	35.19	37.17
Washington	620	550	2.42	2 44	56,000	188,707	1.43	5.28
West Virginia	898	896	3.94	4.05	27,981,617	29,121,480	45.37	48.67
Wyoming	969	851	3.91	3.70	1,468,994	1,948,589	19.50	28.89

SHOOTING OFF THE SOLID.

Much has been said and written in condemnation of the practice, too prevalent in some of the coal-mining States, of "shooting off the solid," that is, of blasting down the coal without having previously undercut or sheared it—in fact, of "making the powder do the work." All authorities agree that the practice is reprehensible in the highest degree. The heavy charges of powder produce an unnecessary quantity of fine coal and render the lump coal so friable that it disintegrates in handling and transportation. The quantity and quality of the merchantable product are thereby materially reduced. These reasons in themselves are sufficient to call forth the condemnation of the practice and the demand for its abolition, but a far stronger reason is the increased liability to accident in a vocation hazardous enough when all precautions possible are taken to promote safety. The use of inordinate charges of powder weakens the roof and supporting pillars and failure to undercut or shear the coal increases the danger of windy shots, the frequent cause of dust explosions. Falls of coal and roof in 1911 were responsible for almost one-half of the 2,700 or so deaths in the coal mines of the United States, and explosions were responsible for 14 per cent. The deaths from the more prolific cause, however, usually happen singly and are not reported outside of the localities where the accidents occur, whereas the less frequent explosions involving the deaths of tens or hundreds of men are given prominence in the daily and technical press.

The statistics of accidents in coal mining and other branches of the mining and quarrying industry in 1911 have been collected by the United States Bureau of Mines and will be published by that bureau.

In collecting the statistics of bituminous coal production the United States Geological Survey's schedules included inquiries as to the percentage of the output mined by hand, by the use of machines, and by shooting off the solid. Replies to these inquiries were made by mines representing more than 90 per cent of the total output. The quantity of coal prepared for shooting by being mined either by hand or by machines amounted to approximately 298,377,000 short tons, or 73.5 per cent of the total production. The quantity of coal shot off the solid amounted to nearly 70,000,000 tons, or 17 per cent of the total. The practice of shooting off the solid appears to have its strongest hold in the interior province, embracing the States of the Mississippi Valley, Michigan, and Texas, although the last named, on account of its large proportion of lignite, has a relatively small percentage (10.3) shot from the solid. The principal offender in this regard is Arkansas, 90 per cent of whose product in 1911 was shot down without having been mined. Oklahoma reported nearly 80 per cent of its total production shot off the solid, Kansas 77.6 per cent, Iowa 68.4 per cent, Missouri 50 per cent, and Indiana and Illinois each 38 per cent. The States of the interior province or Mississippi Valley region altogether, with an aggregate production equal to a little over 23 per cent of the total output of the United States, reported over 60 per cent of the total quantity of coal shot off the solid. The States of the interior province produced in 1911 93,858,654 short tons, of which 42,672,000 tons, or 45.5 per cent, were shot off the solid.

The States of the Appalachian region are largely free from criticism on this point. The highest on the roll of honor in 1911 was Maryland, with only 0.5 per cent of its total production not properly mined. West Virginia was second, with 1 per cent. Pennsylvania, with 35 per cent of the total bituminous production, reported less than 3 per cent shot off the solid, and Ohio, 86 per cent of whose production is machine-mined, also reported less than 3 per cent shot off the solid. Compared with these, Alabama, with 44 per cent of its production shot from the solid, Tennessee with 37.7 per cent, and Virginia with 35.6 per cent, show up unfavorably. Among the Rocky Mountain States, Utah, with 7.7 per cent, and Colorado, with 12.4 per cent, shot off the solid, are the best examples, while Montana, with 34 per cent, and Wyoming, with 39.8 per cent, are the worst. The total percentage in the Rocky Mountain States is much below that of the interior province.

The following table shows the quantities and percentages o bituminous coal in the several States mined by hand and by machines shot off the solid, and by unreported methods, in 1911:

Quantity and percentage of bituminous coal produced by different methods in 1911, by States.

State.	Mined by hand.	Percentage.	Shot off the solid.	Percentage.	Mined by machines.	Percentage.	Not reported.	Percentage.	Total production.
Alabama	4,673,719	31.1	6,623,252	44.1	2,936,512	19.6	787,938	5.2	15,021,421
Alaska	900	100.0							900
Arkansas	131,596	6.2	1,903,728	90.4	27,029	1.3	44,436	2.1	2,106,789
California	10,747	100.0							10,747
Colorado	5,822,282	57.3	1,260,191	12.4	1,975,411	19.5	1,099,499	10.8	10,157,383
Georgia	16,274	9.8					148,936	90.2	165,210
Idaho	230	12.7	1,575	87.3					1,805
Illinois	7,125,008	13.3	20,433,262	38.1	23,093,807	43.0	3,027,041	5.6	53,679,118
Indiana	1,098,903	7.7	5,390,503	38.0	7,049,758	49.6	662,191	4.7	14,201,355
Iowa	1,111,924	15.2	5,017,108	68.4	42,963	.6	1,159,653	15.8	7,331,648
Kansas	422,574	6.8	4,857,714	77.6	100,444	1.6	873,496	14.0	6,254,228
Kentucky	1,766,648	12.9	2,224,147	16.2	9,002,288	65.7	713,756	5.2	13,706,839
Maryland	3,660,778	78.1	24,402	.5	154,301	3.3	846,314	18.1	4,685,795
Michigan	158,480	10.7	548,858	37.2	734,246	49.8	34,490	2.3	1,476,074
Missouri	685,932	18.2	1,893,429	50.4	753,614	20.0	427,632	11.4	3,760,607
Montana	764,938	25.7	1,008,465	33.9	1,172,582	39.4	30,373	1.0	2,976,358
Nevada	16	100.0							16
New Mexico	2,059,844	65.4	981,760	31.2	93,722	3.0	12,832	.4	3,148,158
North Carolina	120	100.0							120
North Dakota	66,659	13.3	133,682	26.6	192,943	38.4	109,344	21.7	502,628
Ohio	2,117,414	6.9	857,234	2.8	26,556,630	86.3	1,228,708	4.0	30,759,986
Oklahoma	168,202	5.5	2,423,307	78.8	87,048	2.8	395,685	12.9	3,074,242
Oregon	4,080	8.7	30,885	66.2			11,696	25.1	46,661
Pennsylvania	49,527,801	34.2	3,962,310	2.7	69,131,923	47.8	22,132,129	15.3	144,754,163
Tennessee	2,267,786	35.2	2,423,515	37.7	914,614	14.2	827,241	12.9	6,433,156
Texas	625,233	31.7	204,092	10.3	71,085	3.6	1,074,183	54.4	1,974,593
Utah	1,993,574	79.3	192,752	7.7	70,653	2.8	256,196	10.2	2,513,175
Virginia	1,865,320	27.2	2,442,562	35.6	2,551,627	37.1	5,158	.1	6,864,667
Washington	2,247,074	62.9	987,196	27.6	188,707	5.3	149,838	4.2	3,572,815
West Vrginia	28,054,005	46.9	626,295	1.0	29,121,480	48.7	2,029,800	3.4	59,831,580
Wyoming	1,956,941	29.0	2,683,322	39.8	1,948,589	28.9	156,012	2.3	6,744,864
Total	120,405,002	29.7	69,135,546	17.0	177,971,976	43.9	38,244,577	9.4	405,757,101

COAL-WASHING OPERATIONS.

A considerable quantity of coal is washed at the mines in order to reduce the percentage of impurities (ash and sulphur), and thus improve the quality of the product. The larger portion of the product so treated is slack used for coke making, but in some cases, as in Illinois and Washington, when the coal is noncoking the washed product is principally nut coal used for domestic fuel. In 1911 the quantity of coal prepared at the mines for coking or for market by washing was 12,543,114 short tons, which yielded 10,999,481 tons of cleaned coal and 1,543,633 tons of refuse. In 1910, 18,395,382 short tons of coal washed yielded 16,035,387 tons of cleaned coal and 2,359,995 tons of refuse. Alabama leads in the quantity of coal washed, and in 1911 Illinois was second, these two States having a total of 8,805,209 tons of coal washed.

In the report on the production of Pennsylvania anthracite, which will be found in the subsequent pages of this chapter and which is also published as a separate pamphlet, it is shown that 3,171,678 long tons, equivalent to 3,552,279 short tons, were recovered by washing from the old culm banks, against 3,296,318 long tons, or 3,691,876 short tons, in 1910. The quantity of coal recovered by the anthracite washeries is not included in the following table, which shows the quantity of bituminous coal washed at the mines in 1910 and 1911:

Bituminous coal washed at the mines in 1910 and 1911, with quantity of washed coal and of refuse obtained from it, by States, in short tons.

1910.

State.	Quantity of coal washed.	Quantity of cleaned coal.	Quantity of refuse.
Alabama	6,772,860	5,971,305	801,555
Arkansas	59,702	44,169	15,533
Colorado	408,374	312,056	96,318
Georgia	84,073	78,208	5,865
Illinois	2,453,208	2,019,396	433,812
Indiana	32,592	29,324	3,268
Kentucky	7,088	6,444	644
Maryland	336	286	50
Michigan	186,128	159,971	26,157
Missouri	52,921	40,748	12,173
Montana	179,565	148,142	31,423
New Mexico	591,611	493,060	98,551
Ohio	174,574	150,707	23,867
Oklahoma	40,790	31,509	9,281
Oregon	38,736	27,115	11,621
Pennsylvania	4,782,246	4,295,439	486,807
Tennessee	571,830	529,111	42,719
Texas	21,296	15,339	5,957
Virginia	13,120	12,696	424
Washington	1,117,166	923,371	193,795
West Virginia	807,166	746,991	60,175
Total	18,395,382	16,035,387	2,359,995

Bituminous coal washed at the mines in 1910 and 1911, with quantity of washed coal and of refuse obtained from it, by States, in short tons—Continued.

1911.

State.	Quantity of coal washed.	Quantity of cleaned coal.	Quantity of refuse.
Alabama	6,251,828	5,538,401	713,427
Arkansas			
Colorado	329,824	228,105	101,719
Georgia	111,579	83,327	28,252
Illinois	2,553,381	2,154,697	398,684
Indiana			
Kentucky	14,500	12,000	2,500
Maryland			
Michigan	234,063	207,135	26,928
Missouri			
Montana	557,770	536,822	20,948
New Mexico			
North Dakota	13,079	12,571	508
Ohio	40,251	38,011	2,240
Oklahoma	10,568	8,449	2,119
Oregon	40,487	30,365	10,122
Pennsylvania	1,346,982	1,226,326	120,656
Tennessee	356,784	328,117	28,667
Texas	37,000	30,375	6,625
Virginia	50,297	42,417	7,880
Washington	392,503	338,708	53,795
West Virginia	202,218	183,655	18,563
Total	12,543,114	10,999,481	1,543,633

PRICES.

The country as a whole being considered, the average prices of both anthracite and bituminous coal have not shown any material changes in the last seven years or since 1903 when the scarcity of fuel caused by the strike in the anthracite mines resulted in the highest prices in the 30 years that the statistics of coal production have been collected by the Survey. Since 1903 the average price of anthracite has ranged from $2.05 to $2.14 per long ton ($1.83 to $1.91 per short ton) and that of bituminous coal from $1.06 to $1.14 per short ton, the lower figures obtaining in the depression year of 1905 and the higher in the boom year of 1907. In 1898 the average price of anthracite was as low as $1.68 per long ton ($1.41 per short ton) and that of bituminous coal as low as 80 cents per short ton. In 1911 the average price for anthracite was $2.17 per long ton ($1.94 per short ton), and for bituminous coal $1.11 per short ton. The average for anthracite in 1911 was 4 cents above that of 1910, while that for bituminous coal was 1 cent less. The following tables show the average price, by States, for the last five years, with the advances and declines for 1911 as compared with 1910, and the general averages for anthracite and bituminous prices for 32 years.

Average price per short ton for coal at the mines since 1907, by States and Territories.

State or Territory.	1907	1908	1909	1910	1911	Advance (+) or decline (−) in 1911.
Alabama	$1.29	$1.26	$1.19	$1.26	$1.27	+$0.01
Arkansas	1.68	1.68	1.48	1.56	1.61	+ .05
California	[a]3.81	[a]3.19	2.21	[a]2.74	[a]2.00	− .74
Colorado	1.40	1.41	1.33	1.42	1.45	+ .03
Georgia	1.38	1.38	1.41	1.46	[b]1.49	+ .03
Idaho	[c]4.10	4.02	4.27	3.92	[d]2.68	− 1.24
Illinois	1.07	1.05	1.05	1.14	1.11	− .03
Indiana	1.08	1.06	1.02	1.13	1.08	− .05
Iowa	1.62	1.63	1.65	1.75	1.73	− .02
Kansas	1.52	1.49	1.44	1.61	1.54	− .07
Kentucky	1.06	1.01	.94	.99	.99	....
Maryland	1.20	1.17	1.11	1.12	1.11	− .01
Michigan	1.80	1.81	1.79	1.91	1.78	− .13
Missouri	1.64	1.64	1.65	1.79	1.71	− .08
Montana	1.94	1.96	1.97	1.82	1.79	− .03
New Mexico	1.46	1.37	1.29	1.39	1.44	+ .05
North Carolina	....	....	....	....	([e])	....
North Dakota	1.61	1.63	1.56	1.49	1.43	− .06
Ohio	1.10	1.06	.99	1.05	1.03	− .02
Oklahoma (Indian Territory)	2.04	2.03	2.00	2.22	2.05	− .17
Oregon	2.34	2.74	2.69	3.48	2.32	− 1.16
Pennsylvania bituminous	1.04	1.01	.94	1.02	1.01	− .01
Tennessee	1.25	1.15	1.09	1.11	1.12	+ .01
Texas	1.69	1.80	1.72	1.67	1.66	− .01
Utah	1.52	1.69	1.66	1.68	1.69	+ .01
Virginia	1.02	.91	.89	.90	.91	+ .01
Washington	2.09	2.21	2.54	2.50	2.29	− .21
West Virginia	.99	.95	.86	.92	.90	− .02
Wyoming	1.56	1.62	1.55	1.55	1.56	+ .01
Total bituminous	1.14	1.12	1.07	1.12	1.11	− .01
Pennsylvania anthracite	1.91	1.90	1.84	1.90	1.94	+ .04
General average	1.28	1.28	1.20	1.25	1.26	+ .01

[a] Includes Alaska.
[b] Includes North Carolina.
[c] Includes Nebraska and Nevada.
[d] Includes Nevada.
[e] Included in Georgia.

Average price per short ton of coal in the United States for 32 years.

Year.	Anthracite.	Bituminous.	Year.	Anthracite.	Bituminous.
1880	$1.47	$1.25	1896	$1.50	$0.83
1881	2.01	1.12	1897	1.51	.81
1882	2.01	1.12	1898	1.41	.80
1883	2.01	1.07	1899	1.46	.87
1884	1.79	.94	1900	1.49	1.04
1885	2.00	1.13	1901	1.67	1.05
1886	1.95	1.05	1902	1.84	1.12
1887	2.01	1.11	1903	2.04	1.24
1888	1.91	1.00	1904	1.90	1.10
1889	1.44	.99	1905	1.83	1.06
1890	1.43	.99	1906	1.85	1.11
1891	1.46	.99	1907	1.91	1.14
1892	1.57	.99	1908	1.90	1.12
1893	1.59	.96	1909	1.84	1.07
1894	1.51	.91	1910	1.90	1.12
1895	1.41	.86	1911	1.94	1.11

SHIPMENTS BY RAILROADS.

From the reports received from producers the following tables, showing the quantity of bituminous coal loaded for shipment by the different railroads in 1910–11, have been compiled. In the statement for 1911 the shipments by waterways have been added. The totals do not represent the entire quantity of coal carried by the various railroad lines. The figures represent only the originating tonnage, that is, the initial shipments over each railroad line or system; consequently the figures are not supposed to represent the total quantity of coal carried by each railroad line, as the tables are made up from reports received from coal operators and not from railroad companies. It has been found necessary to group all of the shipments over any particular system; for instance, the Pennsylvania system includes, in addition to the Pennsylvania Railroad east of Pittsburgh, the Pennsylvania lines including the Pittsburgh, Fort Wayne & Chicago; Pittsburgh, Cincinnati, Chicago & St. Louis; Terre Haute & Indianapolis; Vandalia Railroad; and other subsidiary lines. The New York Central system includes the Lake Shore & Michigan Southern; Cleveland, Cincinnati, Chicago & St. Louis; Pittsburgh & Lake Erie; Chicago, Indiana & Southern; Cincinnati Northern; and other subsidiary lines. The Baltimore & Ohio includes the Baltimore & Ohio Southwestern and the Cincinnati, Hamilton & Dayton. The Frisco lines include the St. Louis & San Francisco Railroad; Chicago & Eastern Illinois; and the Fort Worth & Rio Grande.

The totals as represented in these tables are slightly less than the statement made by the shipments in the tables of production. The reason for this is that a number of operators, usually small ones, did not reply to the inquiries as to the railroad or railroads over which the products were shipped. The total quantity of bituminous coal loaded for shipment in 1910 was 342,969,220 short tons. The distribution by railroads shows shipment of 329,830,069 short tons. This, however, does not include the shipments reported by water, which in 1911 approximated 10,000,000 tons. In 1911 the total quantity of bituminous coal loaded at the mines for shipment was 340,025,580 short tons, and the distribution by railroads gives a total of 326,794,590 short tons, by water 9,751,534 short tons, and a grand total of 336,546,124 short tons. About 20 per cent of the total shipments are sent over the Pennsylvania Railroad and its subsidiary lines, principally from Pennsylvania mines. The total shipments originating on this system amounted in 1910 to 67,103,955 short tons and in 1911 to 64,527,709 short tons. The Baltimore & Ohio system, second in importance, handling a little less than one-half of the Pennsylvania system, had 32,799,866 short tons in 1910 and 30,529,624 short tons in 1911, principally from West Virginia, Pennsylvania, and Ohio mines. The New York Central lines originated 28,175,529 short tons in 1910 and 28,997,411 tons in 1911, chiefly from Pennsylvania mines. The Chesapeake & Ohio and the Norfolk & Western lines are the principal outlets for the coal mines of the southern part of West Virginia. The former handled in 1911 21,198,718 short tons and the latter 19,071,533 short tons. The Frisco system gets its principal tonnage from the mines of Illinois and Indiana, and handled in 1911 14,451,177 short tons. The Illinois Central and the Burlington get their principal tonnage from Illinois; the former had a tonnage of 10,927,366 short tons in 1911 and the latter 9,827,666 tons. Other railroads initiating an excess of 5,000,000 tons in 1911 were the Wabash, 9,195,134 tons; the Southern, 9,352,972 tons; the Buffalo, Rochester & Pittsburgh, 7,143,077 tons; and the Union Pacific and the Southern Pacific lines, 5,557,388 tons. The Missouri Pacific system approached to 6,000,000 in 1910, but dropped to 4,920,263 tons in 1911.

Shipments of bituminous coal in the United States, by railroads, in 1910.

Railroad.	State.	Quantity.	Total.
		Short tons.	
Pennsylvania Railroad system	Pennsylvania	51,892,545	67,103,955
	Ohio	8,442,541	
	Indiana	5,096,759	
	Illinois	1,026,692	
	West Virginia	639,482	
	Maryland	5,936	
Baltimore & Ohio system	West Virginia	12,201,162	32,799,866
	Pennsylvania	10,022,180	
	Ohio	8,377,361	
	Illinois	1,908,151	
	Maryland	174,332	
	Indiana	116,680	
New York Central lines	Pennsylvania	19,936,117	28,175,529
	Illinois	3,419,086	
	Ohio	2,939,078	
	Indiana	1,233,832	
	Michigan	647,416	
Chesapeake & Ohio lines	West Virginia	16,270,372	24,567,361
	Ohio	7,348,411	
	Kentucky	939,855	
	Virginia	8,723	
Norfolk & Western	West Virginia	14,605,670	16,644,525
	Virginia	1,302,938	
	Kentucky	735,917	
Louisville & Nashville	Kentucky	6,886,343	13,467,879
	Alabama	4,092,857	
	Tennessee	1,385,704	
	Illinois	905,840	
	Virginia	197,135	
Frisco lines	Indiana	5,221,989	13,390,727
	Illinois	4,424,947	
	Alabama	1,574,357	
	Kansas	1,283,300	
	Arkansas	564,468	
	Oklahoma	193,900	
	Missouri	127,766	
Wabash	Ohio	4,413,221	11,926,638
	West Virginia	2,657,936	
	Illinois	2,471,522	
	Pennsylvania	2,071,769	
	Missouri	182,665	
	Iowa	129,525	
Southern	Alabama	4,408,801	11,128,253
	Tennessee	3,009,326	
	Virginia	1,152,058	
	Indiana	1,065,736	
	Illinois	912,854	
	Kentucky	579,478	
Illinois Central	Illinois	6,722,157	11,084,140
	Kentucky	3,547,750	
	Alabama	488,332	
	Indiana	325,901	
Burlington	Illinois	4,321,643	8,291,548
	Wyoming	1,770,325	
	Iowa	1,457,455	
	Missouri	491,953	
	Colorado	249,540	
	Kansas	632	
Buffalo, Rochester & Pittsburgh	Pennsylvania	7,009,228	7,009,228
Missouri Pacific	Arkansas	1,546,246	5,859,565
	Illinios	1,507,027	
	Montana	1,465,225	
	Kansas	700,240	
	Missouri	640,827	
Denver & Rio Grande	Colorado	2,883,721	4,875,153
	Utah	1,988,432	
	New Mexico	3,000	
North Western line	Illinois	2,769,658	4,533,579
	Iowa	1,655,878	
	Wyoming	108,043	
Santa Fe	New Mexico	1,497,070	4,279,854
	Kansas	1,150,271	
	Colorado	1,068,185	
	Illinois	281,785	
	Missouri	272,609	
	Oklahoma	9,934	
Cumberland & Pennsylvania	Maryland	3,808,965	3,808,965
Union Pacific—Southern Pacific lines	Wyoming	2,926,067	3,611,748
	Colorado	288,239	
	Texas	159,286	
	Utah	141,020	
	Washington	61,676	
	Kansas	35,460	

Shipments of bituminous coal in the United States, by railroads, in 1910—Continued.

Railroad.	State.	Quantity.	Total.
		Short tons.	
Kanawha & Michigan	West Virginia	3,253,418	3,407,770
	Ohio	154,352	
Rock Island lines	Iowa	1,462,861	2,991,895
	Oklahoma	774,989	
	Illinois	403,472	
	Arkansas	118,153	
	Missouri	102,216	
	Texas	50,077	
	Colorado	44,346	
	Kansas	35,781	
Colorado & Southern Railway lines	Colorado	2,892,482	2,928,482
	Texas	36,000	
Chicago & Alton	Illinois	2,598,499	2,743,202
	Missouri	140,927	
	Indiana	3,776	
Northern Pacific	Washington	2,534,017	2,583,517
	North Dakota	49,500	
Chicago, Milwaukee & St. Paul	Iowa	1,207,841	2,388,660
	Illinois	656,753	
	Montana	331,665	
	Washington	174,199	
	Wyoming	16,600	
	North Dakota	1,602	
Missouri, Kansas & Texas	Oklakoma	1,107,618	2,067,436
	Kansas	599,071	
	Texas	313,171	
	Missouri	47,576	
Chicago, Terre Haute & Southeastern	Indiana	2,045,207	2,045,207
Bessemer & Lake Erie	Pennsylvania	1,720,965	1,720,965
Erie	....do	1,601,775	1,703,823
	Ohio	102,048	
Buffalo and Susquehanna	Pennsylvania	1,477,440	1,477,440
Virginian	West Virginia	1,400.954	1,400,954
Pittsburg, Shawmut & Northern	Pennsylvania	1,264,949	1,264,949
Nashville, Chattanooga & St. Louis	Tennessee	1,201,594	1,216,594
	Alabama	15,000	
Mobile & Ohio	Illinois	874,083	1,198,343
	Alabama	324,260	
Litchfield & Madison	Illinois	1,156,770	1,156,770
Western Maryland	Maryland	1,107,125	1,107,125
Queen & Crescent	Tennessee	638,219	1,036,499
	Kentucky	388,300	
	Alabama	9,980	
St. Louis, Troy & Eastern	Illinois	1,005,016	1,005,016
Minneapolis & St. Louis	Iowa	552,262	988,580
	Illinois	392,029	
	Wyoming	44,289	
St. Louis & O'Fallon	Illinois	960,015	960,015
Carolina, Clinchfield & Ohio	Virginia	958,971	958,971
Great Northern Railway lines	Montana	859,412	909,201
	Washington	34,551	
	North Dakota	15,238	
El Paso and Southwestern	New Mexico	783,410	783,410
Texas & Pacific	Texas	750,224	750,224
Colorado & Southeastern	Colorado	728,477	728,477
Coal & Coke	West Virginia	725,829	725,829
Kansas City Southern	Kansas	668,362	719,806
	Oklahoma	25,033	
	Arkansas	16,941	
	Missouri	9,470	
Columbia & Puget Sound	Washington	713,761	713,761
Huntingdon & Broad Top Mountain	Pennsylvania	669,816	669,816
Pere Marquette	Michigan	660,589	660,589
Monon	Indiana	576,073	576,073
Western Allegheny	Pennsylvania	575,766	575,766
Elgin, Joliet & Eastern	Illinois	506,609	506,609
Chicago, Peoria & St. Louis Railway of Illinois	.....do	493,332	493,332
Union	Pennsylvania	473,586	473,586
Midland Valley	Arkansas	432,569	472,354
	Oklahoma	39,785	
Denver, Northwestern & Pacific	Colorado	465,214	465,214
Missouri & Louisiana	Missouri	391,434	462,827
	Arkansas	71,393	
International & Great Northern	Texas	458,847	458,847
St. Louis, Rocky Mountain & Pacific	New Mexico	437,148	437,148
Interstate	Virginia	433,888	433,888
Colorado & Wyoming	Colorado	420,964	420,964
Colorado Midland	.....do	416,732	416,732
East Broad Top Railroad & Coal Co	Pennsylvania	379,367	379.367
Central of Georgia	Alabama	367,914	367,914
Chicago Great Western	Iowa	355,603	363,812
	Kansas	8,209	

Shipments of bituminous coal in the United States, by railroads, in 1910—Continued.

Railroad.	State.	Quantity.	Total.
		Short tons.	
Detroit, Toledo & Ironton	Ohio	348,643	348,643
Ligonier Valley	Pennsylvania	313,132	313,132
St. Louis & Belleville Electric	Illinois	310,543	310,543
Morgantown & Kingwood	West Virginia	279,099	279,099
Illinois Southern	Illinois	276,535	276,535
Monongahela	Pennsylvania	240,018	240,018
Fort Dodge, Des Moines & Southern	Iowa	239,738	239,738
Chicago & Illinois Midland	Illinois	210,035	210,035
Minneapolis, St. Paul & Sault Ste. Marie	North Dakota	200,797	200,797
Toledo, Peoria & Western	Illinois	196,082	196,082
Peoria & Pekin Union	do	194,895	194,895
Fort Smith & Western	Oklahoma	182,786	182,786
Illinois Traction System	Illinois	145,223	145,223
Quincy, Omaha & Kansas City	Missouri	140,534	140,534
Louisville, Henderson & St. Louis	Kentucky	131,104	131,104
Ashland Coal & Iron	do	123,577	123,577
Marietta, Columbus & Cleveland	Ohio	85,454	85,454
Missouri, Oklahoma & Gulf	Oklahoma	84,497	84,497
Pittsburg & Susquehanna	Pennsylvania	78,357	78,357
Seaboard Air Line	Alabama	77,999	77,999
Wichita Falls & Southern	Texas	50,000	50,000
Atlanta, Birmingham & Atlantic	Alabama	44,962	44,962
Miscellaneous	Illinois	735,253	999,787
	Pennsylvania	259,968	
	Ohio	4,566	
Total		329,830,069	329,830,069

Shipments of bituminous coal in the United States, by railroads and waterways, in 1911.

Railroad.	State.	Quantity.	Total.
		Short tons.	
Pennsylvania Railroad system	Pennsylvania	52,724,293	64,527,709
	Ohio	7,460,091	
	Indiana	2,733,963	
	Illinois	929,032	
	West Virginia	666,927	
	Maryland	13,403	
Baltimore & Ohio system	West Virginia	11,624,625	30,529,624
	Pennsylvania	10,319,280	
	Ohio	7,025,625	
	Illinois	1,300,794	
	Maryland	158,000	
	Indiana	101,300	
New York Central lines	Pennsylvania	18,331,373	28,997,411
	Illinois	5,083,070	
	Ohio	4,024,705	
	Indiana	999,105	
	Michigan	559,158	
Chesapeake & Ohio lines	West Virginia	15,962,497	21,198,718
	Ohio	3,884,921	
	Kentucky	1,329,292	
	Virginia	22,008	
Norfolk & Western	West Virginia	16,062,746	19,071,533
	Virginia	2,201,402	
	Kentucky	807,385	
Frisco lines	Illinois	5,416,803	14,451,177
	Indiana	4,842,966	
	Kansas	1,695,727	
	Alabama	1,523,319	
	Arkansas	544,637	
	Oklahoma	235,975	
	Missouri	191,750	
Louisville & Nashville	Kentucky	5,772,277	11,737,201
	Alabama	3,793,381	
	Tennessee	1,401,537	
	Illinois	576,870	
	Virginia	193,136	
Illinois Central	Illinois	7,358,101	10,927,366
	Kentucky	3,201,168	
	Indiana	321,387	
	Alabama	46,710	

Shipments of bituminous coal in the United States, by railroads and waterways, in 1911—Continued.

Railroad.	State.	Quantity.	Total.
		Short tons.	
Burlington	Illinois	6,421,228	9,827,666
	Wyoming	1,510,179	
	Iowa	1,209,075	
	Colorado	362,655	
	Missouri	324,304	
	Kansas	225	
Southern	Alabama	3,856,981	9,352,972
	Tennessee	2,261,543	
	Virginia	1,153,561	
	Illinois	787,396	
	Indiana	739,972	
	Kentucky	553,519	
Wabash	Ohio	4,020,635	9,195,134
	Illinois	3,025,675	
	Pennsylvania	1,745,069	
	Missouri	316,677	
	Iowa	87,078	
Buffalo, Rochester & Pittsburgh (Rural Valley)	Pennsylvania	7,143,077	7,143,077
Union Pacific-Southern Pacific lines	Wyoming	4,698,825	5,557,388
	Colorado	464,995	
	Texas	129,704	
	Utah	106,999	
	Washington	105,000	
	Kansas	51,865	
Missouri Pacific	Illinois	2,228,462	4,920,263
	Kansas	1,164,615	
	Missouri	765,457	
	Arkansas	759,732	
	Colorado	1,997	
Santa Fe	Kansas	1,431,858	4,555,933
	New Mexico	1,442,427	
	Colorado	864,488	
	Illinois	448,375	
	Missouri	351,914	
	Oklahoma	9,263	
	Texas	7,608	
Denver & Rio Grande	Colorado	2,151,986	4,052,479
	Utah	1,897,893	
	New Mexico	2,600	
Kanawha & Michigan	West Virginia	2,918,049	3,793,795
	Ohio	875,746	
Western Maryland	West Virginia	2,258,324	3,386,525
	Maryland	1,128,201	
Chicago & Alton	Illinois	3,016,604	3,196,937
	Missouri	180,333	
Missouri, Kansas & Texas	Oklahoma	1,396,505	2,844,647
	Kansas	989,617	
	Texas	323,731	
	Missouri	134,794	
Rock Island lines	Iowa	946,020	2,817,481
	Oklahoma	733,006	
	Illinois	560,586	
	Arkansas	228,527	
	Missouri	197,233	
	Texas	57,612	
	Kansas	52,500	
	Colorado	41,997	
North Western line	Iowa	1,610,031	2,789,425
	Illinois	1,028,920	
	Wyoming	150,474	
Chicago, Milwaukee & St. Paul	Illinois	1,419,749	2,700,520
	Iowa	1,201,130	
	Washington	75,614	
	North Dakota	4,027	
Colorado & Southern Railway lines	Colorado	2,578,541	2,614,916
	Texas	34,700	
	New Mexico	1,675	
Chicago, Terre Haute & Southeastern	Indiana	2,507,566	2,507,566
Virginian	West Virginia	2,375,283	2,375,283
Northern Pacific	Washington	2,272,068	2,342,882
	North Dakota	57,085	
	Wyoming	13,729	
Cumberland & Pennsylvania	Maryland	2,190,432	2,192,543
	Pennsylvania	2,111	
Macoupin County	Illinois	2,033,860	2,033,860
Bessemer & Lake Erie	Pennsylvania	1,971,484	1,971,484
Erie	do	1,782,207	1,900,641
	Ohio	118,434	
Buffalo & Susquehanna	Pennsylvania	1,656,507	1,656,507
Pittsburg, Shawmut & Northern	do	1,440,063	1,440,063

Shipments of bituminous coal in the United States, by railroads and waterways, in 1911—Continued.

Railroad.	State.	Quantity.	Total.
		Short tons.	
Mobile & Ohio	Illinois	785,469	1,348,478
	Alabama	563,009	
Nashville, Chattanooga & St. Louis	Tennessee	1,154,635	1,169,435
	Alabama	14,800	
Queen and Crescent	Tennessee	723,044	1,124,187
	Kentucky	401,143	
Minneapolis & St. Louis	Iowa	634,419	1,123,417
	Illinois	488,998	
Carolina, Clinchfield & Ohio	Virginia	1,116,403	1,116,403
St. Louis, Troy & Eastern	Illinois	824,740	824,740
Texas & Pacific	Texas	797,811	797,811
Pittsburgh, Chartiers & Youghiogheny	Pennsylvania	750,525	750,525
Litchfield & Madison	Illinois	747,892	747,892
Kansas City Southern	Kansas	680,949	702,579
	Missouri	18,342	
	Arkansas	3,163	
	Oklahoma	125	
Pere Marquette	Michigan	678,366	678,366
Colorado & Southeastern	Colorado	676,240	676,240
Chicago Great Northern	Iowa	395,277	675,336
	Illinois	259,059	
	Kansas	21,000	
Columbia & Puget Sound	Washington	618,564	618,564
Birmingham Southern	Alabama	597,906	597,906
Coal & Coke	West Virginia	588,775	588,775
El Paso & Southwestern	New Mexico	571,101	571,101
Huntingdon & Broad Top Mountain	Pennsylvania	568,625	568,625
St. Louis & O'Fallon	Illinois	543,735	543,735
Elgin, Joliet & Eastern	do	539,260	539,260
Interstate	Virginia	531,846	531,846
Monon	Indiana	524,714	524,714
Central of Georgia	Alabama	431,860	508,001
	Georgia	76,141	
East Broadtop Railroad & Coal Co	Pennsylvania	493,594	493,594
Midland Valley	Arkansas	410,465	485,875
	Oklahoma	75,410	
Chicago & Illinois Midland	Illinois	480,252	480,252
Missouri & Louisiana	Missouri	458,837	474,988
	Arkansas	16,151	
Western Allegheny	Pennsylvania	465,227	465,227
Chicago, Peoria & St. Louis Railway of Illinois	Illinois	459,645	459,645
International & Great Northern	Texas	426,048	426,048
Springfield Terminal	Illinois	394,510	394,510
St. Paul & Kansas City Short Line	Iowa	310,586	310,586
Toledo, Peoria & Western	Illinois	306,819	306,819
Colorado & Wyoming	Colorado	296,686	296,686
St. Louis, Rocky Mountain & Pacific	New Mexico	290,659	290,659
Colorado Midland	do	282,389	282,389
Detroit, Toledo & Ironton	Ohio	279,797	279,797
Morgantown & Kingwood	West Virginia	275,132	275,132
St. Louis & Belleville Electric	Illinois	266,969	266,969
Peoria & Pekin Union	do	263,423	263,423
Denver, Northwestern & Pacific	Colorado	261,538	261,538
Quincy, Omaha & Kansas City	Missouri	260,856	260,856
Minneapolis, St. Paul & Sault Ste. Marie	North Dakota	257,528	257,528
Illinois Southern	Illinois	245,986	245,986
Ligonier Valley	Pennsylvania	233,215	233,215
Tennessee Central	Tennessee	210,645	210,645
Fort Smith & Western	Oklahoma	177,263	177,263
Missouri, Oklahoma & Gulf	do	152,375	152,375
Rock Island Southern	Illinois	139,867	139,867
Puget Sound Electric	Washington	111,247	111,247
Atlanta, Birmingham & Atlantic	Alabama	98,853	98,853
Evansville, Suburban & Newburgh	Indiana	97,259	97,259
Illinois Traction System	Illinois	95,937	95,937
Louisville, Henderson & St. Louis	Kentucky	95,086	95,086
Colfax Northern	Iowa	92,598	92,598
Buffalo Creek & Gauley	West Virginia	87,081	87,081
Great Northern Railway Lines	North Dakota	36,324	80,094
	Washington	30,041	
	Wyoming	13,729	
Fort Dodge, Des Moines & Southern	Iowa	79,833	79,833
Seaboard Air Line	Alabama	77,260	77,260
Ashland Coal & Iron	Kentucky	67,047	67,047
Kanawha & West Virginia	West Virginia	62,565	62,565
Pittsburg & Susquehanna	Pennsylvania	62,043	62,043
Wichita Falls & Southern	Texas	51,514	51,514
San Antonio & Aransas Pass	do	35,000	35,000
Union	Pennsylvania	23,692	23,692
Marietta, Columbus & Cleveland	Ohio	22,785	22,785

Shipments of bituminous coal in the United States, by railroads and waterways, in 1911—Continued.

Railroad.	State.	Quantity.	Total.
		Short tons.	
Monongahela	Pennsylvania	14,200	14,200
Miscellaneous	Illinois	595,846	1,409,962
	Ohio	155,914	
	Kentucky	149,807	
	Alabama	119,247	
	Michigan	109,620	
	Indiana	62,530	
	Pennsylvania	47,026	
	Oklahoma	35,201	
	Missouri	25,009	
	West Virginia	22,923	
	Arkansas	19,729	
	Oregon	17,645	
	Texas	14,400	
	Washington	13,899	
	Virginia	12,538	
	Iowa	8,158	
	Kansas	450	
	North Carolina	20	
Total railroad shipments		326,794,590	326,794,590
Monongahela River	Pennsylvania	6,968,733	6,968,733
Kanawha River	West Virginia	1,060,061	1,060,061
Ohio River	Kentucky	245,066	557,223
	West Virginia	142,873	
	Ohio	116,106	
	Pennsylvania	53,178	
Allegheny River	do	68,712	68,712
Warrior River	Alabama	8,000	8,000
Various waterways	Maryland	1,039,867	1,088,805
	Illinois	28,878	
	West Virginia	15,298	
	Oregon	4,762	
Total waterway shipments		9,751,534	9,751,534
Grand total		336,546,124	336,546,124

IMPORTS AND EXPORTS.

The following tables have been compiled from official returns to the Bureau of Statistics of the Department of Commerce and Labor, and show the imports and exports of coal from 1907 to 1911, inclusive. The values given in both cases are considerably higher than the average "spot" rates by which the values of the domestic production have been computed.

The tariff from 1824 to 1843 was 6 cents per bushel, or $1.68 per long ton; from 1843 to 1846, $1.75 per ton; 1846 to 1857, 30 per cent ad valorem; 1857 to 1861, 24 per cent ad valorem; 1861, bituminous and shale, $1 per ton; all other, 50 cents per ton; 1862 to 1864, bituminous and shale, $1.10 per ton; all other, 60 cents per ton; 1864 to 1872, bituminous and shale, $1.25 per ton; all other, 40 cents per ton. By the act of 1872 the tariff on bituminous coal and shale was made 75 cents per ton, and so continued until the act of August, 1894, changed it to 40 cents per ton. On slack or culm the tariff was made 40 cents per ton by the act of 1872; was changed to 30 cents per ton by the act of March, 1883, and so continued until the act of August, 1894, changed it to 15 cents per ton. The tariff act of 1897 provided that all coals which contain less than 92 per cent fixed carbon, and which will pass over a half-inch screen, shall pay a duty of 67 cents per ton. Slack or culm was not changed by the act of 1897. Tons are all 2,240 pounds. Anthracite coal has been free of duty since 1870. During the period from June, 1854, to March, 1866, the reciprocity treaty was in force, and coal from the British possessions in North America was admitted into the United States duty free. A special act of Congress placed all the coal on the free list for one year from January 1, 1903, in order to relieve the shortage caused by the anthracite strike of 1902. Under the tariff act approved August 5, 1909, anthracite is practically excluded. It remains on the free list, but only as coal stores for American vessels, and must not be unloaded. The rate on bituminous coal is placed at 45 cents per long ton, and the rate on slack or culm is fixed at 15 cents per ton.

The exports consist of anthracite and bituminous coal, the quantity of bituminous being the greater in the last few years. They are made principally by rail over the international bridges and by lake and sea to the Canadian Provinces. Exports are also made by sea to the West Indies, to Central and South America, and elsewhere.

The imports are principally from Australia and British Columbia to San Francisco, from Great Britain to the Atlantic and Pacific coasts, and from Nova Scotia to Atlantic coast points.

The total exports of coal from the United States during 1911 were 17,432,753 long tons (equivalent to 19,524,683 short tons), valued at $52,593,274, compared with 13,805,866 long tons (or 15,462,570 short tons), valued at $41,470,792, in 1910. Of the exports in 1911, 3,553,999 long tons (3,980,479 short tons), valued at $18,093,285, were anthracite, and 13,878,754 long tons (15,544,204 short tons), valued at $34,499,989, were bituminous coal. From this it appears that the exports of anthracite increased more than 500,000 tons in 1911, and that the exports of bituminous coal increased a little more than 3,000,000 tons. The imports of anthracite are unimportant, having amounted in 1911 to 2,463 long tons, valued at $12,550. The imports of bituminous coal and shale amounted to 1,234,998 long tons (equivalent to 1,383,198 short tons), valued at $3,604,797, in 1911. The total imports were 1,385,956 short tons, valued at $3,617,347. The imports in 1911 include 361,704 long tons (or 405,108 short tons), valued at $721,750, of slack or culm (passing ½-inch screen). This is used for coke making at Everett, near Boston, Mass. Most of the anthracite imported into the United States is to San Francisco and other points on the Pacific coast, and is brought in principally as ballast in vessels coming for outgoing cargoes. Compared with the domestic production, the total quantity of coal imported into the United States is of little consequence. The imports during the last three years have been less than 0.33 per cent of the production.

Coal of domestic production exported from the United States, 1907–1911, in long tons.

Year.	Anthracite.		Bituminous and shale.	
	Quantity.	Value.	Quantity.	Value.
1907	2,698,072	$13,217,985	10,448,676	$26,972,908
1908	2,752,358	13,524,595	9,100,819	23,361,914
1909	2,842,714	14,141,468	9,693,843	24,300,050
1910	3,021,627	14,785,387	10,784,239	26,685,405
1911	3,553,999	18,093,285	13,878,754	34,499,989

Coal imported and entered for consumption in the United States, 1907–1911, in long tons.

Year.	Anthracite.		Bituminous and shale.	
	Quantity.	Value.	Quantity.	Value.
1907	9,897	$40,971	2,103,711	$5,397,222
1908	16,484	73,778	1,452,662	3,964,843
1909	3,191	12,918	1,274,903	3,628,533
1910	8,196	42,244	1,986,258	4,761,223
1911	2,463	12,550	[a] 1,234,998	3,604,797

[a] Includes 361,704 tons of slack or culm (value $721,750) passing ½-inch screen.

WORLD'S PRODUCTION OF COAL.

Since 1899 when the United States supplanted Great Britain, this country has held first place among the coal producing countries of the world. In 1911 the total world's production of coal amounted to approximately 1,300,000,000 short tons, of which the United States contributed 496,221,168 tons, or 38.1 per cent. In the 12 years from 1899, when the country first surpassed Great Britain, to 1911 the production of the United States has increased nearly 100 per cent, while Great Britain has increased its output about 25 per cent, from 246,506,155 short tons to 304,518,927 tons. The United States in 1911 produced nearly 192,000,000 tons, or over 60 per cent, more than Great Britain. Germany's production of coal and lignite in 1899 was 149,719,766 short tons; in 1911 it was 258,223,763 tons, an increase of over 70 per cent. The combined production of Great Britain and Germany in 1911 was 562,742,690 short tons, which exceeded the output of the United States by 66,521,522 tons, or 11.5 per cent. The three countries, United States, Great Britain, and Germany produce more than 80 per cent of the world's total supply of coal.

The writer is indebted, for the figures of the production of foreign countries as shown in the following table, to Mr. James M. Swank, general manager of the American Iron and Steel Association, of Philadelphia. The statistics are for the years nearest to 1911 for which the figures are available. For the sake of convenience the quantities are expressed in the measurement customary in each country and are reduced for comparison to short tons of 2,000 pounds.

The world's production of coal.

Countries.		Usual unit in producing country.	Equivalent in short tons.
United States (1911)	long tons	443,054,614	496,221,168
Great Britain (1911)	do	271,891,899	304,518,927
Germany (1911)	metric tons	234,259,061	258,223,763
Austria-Hungary (1910)	do	48,649,768	53,626,639
France (1911)	do	39,350,041	43,375,550
Russia and Finland (1911)	do	23,197,000	25,570,053
Belgium (1911)	do	23,125,140	25,490,842
Japan (1910)	do	15,681,324	17,285,523
China (1910)	do	15,000,000	16,534,500
India (1910)	long tons	12,047,413	13,493,103
Canada (1911)	short tons	11,291,553	11,291,553
New South Wales (1911)	long tons	8,691,604	9,734,596
Spain (1910)	metric tons	4,057,532	4,472,618
Transvaal (1911)	long tons	3,878,286	4,343,680
Mexico (1910)	metric tons	2,450,000	2,700,635
Natal (1911)	long tons	2,394,238	2,681,547

The world's production of coal—Continued.

Countries.	Usual unit in producing country.	Equivalent in short tons.
New Zealand (1910) long tons	2,197,362	2,461,045
Asiatic Russia (1910) metric tons	1,244,000	1,371,261
Chile (1911) do	1,158,660	1,277,191
Holland (1909) do	1,120,852	1,235,515
Queensland (1911) long tons	891,568	998,556
Bosnia and Herzegovina (1911) metric tons	769,763	848,510
Brazil, Switzerland, and Turkey[1] do	745,000	821,215
Italy (1910) do	562,153	619,661
Orange Free State (Orange River Colony) (1910) long tons	504,445	564,978
Dutch East Indies (1909) metric tons	508,771	560,818
Indo-China (1909) do	384,053	423,342
Victoria (1910) long tons	369,059	413,346
Sweden (1911) metric tons	311,809	343,707
Peru (1908) do	311,122	342,950
Servia (1909) do	292,300	322,202
Bulgaria (1909) do	227,362	250,621
Western Australia (1909) long tons	214,302	240,018
Formosa (1909) metric tons	183,412	202,175
Roumania (1907-8) do	160,783	177,231
Rhodesia (1909) long tons	152,583	170,893
British Borneo (1909) do	130,985	146,703
Cape Colony (Cape of Good Hope) (1910) do	87,551	98,057
Tasmania (1910) do	82,455	92,350
Korea (1909) do	53,493	59,912
Spitzbergen (1910) metric tons	40,000	44,092
Philippine Islands (1910) do	27,000	29,762
Venezuela (1906) do	14,064	15,503
Portugal (1909) do	6,274	6,916
Greece (1909) do	3,873	4,269
Unspecified long tons	50,000	56,000
Total		1,303,763,496
Percentage of the United States		38.1

[1] Brazil 1909, Turkey 1911; no date for Switzerland.

As a matter of historical interest the following table, giving the statistics of the production of coal in the more important countries of the world since 1868, is presented. In the 42 years covered by this table the percentage of the total contributed by the United States increased from less than 15 per cent in 1868 to nearly 40 per cent in 1907, but decreased to 35.6 per cent in 1908. In 1909 the United States produced 37.49 per cent of the world's total, 39.2 per cent in 1910, and 38.10 per cent in 1911.

World's production of coal, by countries, 1868–1911.

Year.	United States.		Great Britain.		Germany.	
	Long tons.	Short tons.	Long tons.	Short tons.	Metric tons.	Short tons.
1868	29,341,036	32,861,960	103,141,157	115,518,096	32,879,123	36,249,233
1869	29,378,893	32,904,360	107,427,557	120,318,864	34,343,913	37,864,164
1870	29,496,054	33,035,580	110,431,192	123,682,935	34,003,004	37,488,312
1871	41,861,679	46,885,080	117,352,028	131,434,271	37,856,110	41,736,361
1872	45,940,535	51,453,399	123,497,316	138,316,994	42,324,467	46,662,725
1873	51,430,786	57,602,480	128,680,131	144,121,747	46,145,194	50,875,076
1874	46,969,571	52,605,920	126,590,108	141,780,921	46,658,145	51,440,605
1875	46,739,571	52,348,320	133,306,485	149,303,263	47,804,054	52,703,970
1876	47,571,429	53,280,000	134,125,166	150,220,186	49,550,461	54,629,383
1877	54,019,429	60,501,760	134,179,968	150.281.564	48,229,882	53,173,445
1878	51,728,214	57,935,600	132,612,063	148,525,511	50,519,899	55,698,188
1879	60,808,749	68,105,799	133,720,393	149,766,840	53,470,716	58,951,464
1880	63,822,830	71,481,570	146,969,409	164,605,738	59,118,035	65,177,634
1881	76,679,491	85,881,030	154,184,300	172,686,416	61,540,485	67,848,385
1882	92,456,419	103,551,189	156,499,977	175,279,974	65,378,211	72,079,478
1883	103,310,290	115,707,525	163,737,327	183,385,806	70,442,648	77,663,019
1884	107,281,742	120,155,551	160,757,779	180,048,712	72,113,820	79,505,487
1885	99,250,263	111,160,295	159,351,418	178,473,588	73,675,515	81,227,255

World's production of coal, by countries, 1868–1911—Continued.

Year.	United States.		Great Britain.		Germany.	
	Long tons.	Short tons.	Long tons.	Short tons.	Metric tons.	Short tons.
1886	101,500,381	113,680,427	157,518,482	176,420,700	73,682,584	81,235,049
1887	116,652,242	130,650,511	162,119,812	181,574,189	76,232,618	84,046,461
1888	132,731,837	148,659,657	169,935,219	190,327,445	81,960,083	90,360,992
1889	126,097,779	141,229,513	176,916,724	198,146.731	84,973,230	93,640,500
1890	140,866,931	157,770,963	181,614,288	203,408,003	89,290,834	98,398,500
1891	150,505,954	168,566,669	185,479,126	207,736,621	94,252,278	103,913,136
1892	160,115,242	179,329,071	181,786,871	203,601,296	92,544,050	102,029,815
1893	162,814,977	182,352,774	167,325,795	184,044.890	95,426,153	105,207,334
1894	152,447,791	170,741,526	188,277,525	210,870,828	98,805,702	108,883,884
1895	172,426,366	193,117,530	189,661,362	212,320,725	103,957,639	114,561,318
1896	171,416,390	191,986,357	195,361,260	218,804,611	112,471,106	123,943,159
1897	178,776,070	200,229,199	202,129,931	226,385,523	120,474,485	132,762,882
1898	196,407,382	219,976,267	202,054,516	226,301,058	130,928,490	144,283,196
1899	226,554,635	253,741,192	220,094,781	246,506,155	135,824,427	149,719,766
1900	240,789,310	269,684,027	225,181,300	252,203,056	149,551.000	164,805,202
1901	261,874,836	293,299,816	219,046,945	245,332,578	152,628,931	168,217,082
1902	269,277,178	301,590,439	227,095,042	254,346,447	150,436,810	165,826,496
1903	319,068,229	357,356,416	230,334,469	257,974,605	162,457,253	179,076,630
1904	314,121,784	351,816,398	232,428,272	260,319,665	169,450,583	186,785,378
1905	350,645,210	392,722,635	236,128,936	264,464,408	173,796,674	191,576,074
1906	369,783,284	414,157,278	251,067,628	281,195,743	201,715,074	222,350,526
1907	428,895,914	480,363,424	267,830,962	299,970,677	205,727,665	226,773,605
1908	371,288,123	415,842,698	261,506,379	292,887,144	215,283,474	237,306,973
1909	411,441,621	460,814,616	263,774,312	295,427,229	217,433,488	239,676,934
1910	447,853,909	501,596,378	264,433,028	296,164,991	222,301,660	245,043,120
1911	443,054,614	496,221,168	271,891,899	304,518,927	234,259,061	258,223,763

Year.	Austria-Hungary.		France.		Belgium.	
	Metric tons.	Short tons.	Metric tons.	Short tons.	Metric tons.	Short tons.
1868	7,021,756	7,741,486	13,330,826	14,697,236	12,298,589	13,559,194
1869	7,663,043	8,448,505	13,509,745	14,894,494	12,943,994	14,270,753
1870	8,355,945	9,212,429	13,179,788	14,530,716	13,697,118	15,101,073
1871	8,437,401	9,302,235	13,240,135	14,597,249	13,733.176	15,140,827
1872	8,825,896	9,730,550	16,100,773	17,751,102	15,658,948	17,263,990
1873	10,104,769	11,140,508	17,479,341	19,270,973	15,778,401	17,395,687
1874	12,631,364	13,926,079	16,907,913	18,640,974	14,669,029	16,172,604
1875	13,062,738	14,395,137	16,956,840	18,694,916	15,011,331	16,549,992
1876	13,000,000	14,327,300	17,101,448	18,854,346	14,329,578	15,798,360
1877	13,500,000	14,883,750	16,804,529	18,526,993	13,669,077	15,070,157
1878	13,900,000	15,324,750	16,960,916	18,699.410	14,899,175	16,426,340
1879	14,500,000	15,986,250	17,110,979	18,864,854	15,447,292	17,030,640
1880	14,800,000	16,317,000	19,361,564	21,346,124	16,886,698	18,617,585
1881	15,304,813	16,873,556	19,765,983	21,791,996	16,873,951	18,603,531
1882	15,555,292	17,149,709	20,603,704	22,715,584	17,590,989	19,394,065
1883	17,047,961	18,795,377	21,333,884	23,520,607	18,177,754	20,040,974
1884	18,000,000	19,845,000	20,023,514	22,075,924	18,051,499	19,901,778
1885	20,435,463	22,530,098	19,510,530	21,510,359	17,437,603	19,224,957
1886	20,779,441	22,909,334	19,909,894	21,950,658	17,285,543	19,057,311
1887	21,879,172	24,121,787	21,287,589	23,469,567	18,378,624	20,262,433
1888	23,859,608	26,305,218	22,602,894	24,919,691	19,218,481	21,188,375
1889	25,328,417	27,924,580	24,303,509	26,794,619	19,869,980	21,906,653
1890	27,504,032	30,323,195	26,083,118	28,756,638	20,365,960	22,453,471
1891	28,823,240	31,777,622	26,024,893	28,692,444	19,675,644	21,692,398
1892	29,037,978	32,014,371	26,178,701	28,862,018	19,583,173	21,590,448
1893	30,449,304	33,570,358	25,650,981	28,280,207	19,410,519	21,400,097
1894	31,492,000	34,704,184	27,459,137	30,273,699	20,458,827	22,555,857
1895	32,654,777	35,985,564	28,019,893	30,877,922	20,450,604	22,536,566
1896	33,676,411	37,111,405	29,189,900	32,167,270	21,252,370	23,420,112
1897	35,858,000	39,515,516	30,797,629	33,938,987	21,534,629	23,731,161
1898	37,786,963	41,652,569	32,356,104	35,656,426	22,075,093	24,326,752
1899	38,739,000	42,690,378	32,863,000	36,215,026	21,917,740	24,159,925
1900	39,029,729	43,010,761	33,404,298	36,811,536	23,462,817	25,856,024

World's production of coal, by countries, 1868-1911—Continued.

Year.	Austria-Hungary.		France.		Belgium.	
	Metric tons.	Short tons.	Metric tons.	Short tons.	Metric tons.	Short tons.
1901	41.202.902	45,417,959	32,301,757	35,596,536	22,213,410	24,485,842
1902	39,479,560	43,518,319	30,196,994	33,286,146	22,877,470	25,217,835
1903	40,628,785	44.772,921	34,906,418	38,466,873	23,796,680	26,223,941
1904	41,014,182	45,209,933	34,167,966	37,663,349	22.761,430	25,089,924
1905	42,994,240	47,392,551	35,336,442	38,951,360	21,844,200	24,078,862
1906	45,568,434	50,230,085	34,313,645	37,823,931	23,610,740	26,026,119
1907	48,180,849	53,109,750	36,930,250	40,708,215	23,824,499	26,261,745
1908	49.280,786	54,322,210	37,622,556	41,471,343	22,679,300	24,999,392
1909	49,509,016	54,573,788	37,971,758	41,856,269	23,517,550	25,923,395
1910	48,649,768	53,626,639	38,570,473	42,516,232	23,927,230	26,374,986
1911			39,350,041	43,375,550	23,125,140	25,490,842

Year.	Russia.		Japan.		Other countries.	Total.	Per cent of United States.
	Metric tons.	Short tons.	Metric tons.	Short tons.	Short tons.	Short tons.	
1868	430,032	473,895			1,147,330	222,248,430	14.79
1869	579,419	638,510			1,104,563	230,444,213	14.28
1870	667,806	735,922			1,063,121	234,850,088	14.07
1871	772,371	851,153			1,114,248	261,061,424	17.96
1872	1,037,611	1,143,447			1,268,115	283,590,322	18.14
1873	1,154,618	1,272,389			1,502,516	303,181,376	19.00
1874	1,270,889	1,400,520			2.708,756	298,676,379	17.61
1875	1,673,753	1,844,475			2,639,104	308,479,177	16.97
1876	1,795,146	1,968,251			2,597,143	311,674,969	17.09
1877	1,760,276	1,939,824			2,821,155	317,198,648	19.07
1878	2,483,575	2,738,141			3,176,050	318,523,990	18.19
1879	2,874,790	3,169,456			3,362,605	335,237,908	20.32
1880	3,238,470	3,570,413			3,621,342	364,737,406	19.60
1881	3,439,787	3,792,365			5,185,974	392,663,253	21.87
1882	3,672,782	4,049,242			6,128,631	420,347,872	24.63
1883	3,916,105	4,317,506	1,021,000	1,125,142	6,929,841	451,485,797	25.62
1884	3,869,689	4,266,332	1,159,000	1,277,218	7,367,309	454.443,311	26.44
1885	4,207,905	4,639,215	1,314,000	1,448,028	7,570,507	447,784,302	24.82
1886	4,506,027	4,967,895	1,402.000	1,545,004	9,082,815	450,849,193	25.21
1887	4,464,174	4.921.752	1,785.000	1.967.070	10,399.273	481,413,043	27.14
1888	5,187,312	5.719.011	2,044,000	2.252.488	11,493.176	521.226.053	28.52
1889	6,215,577	6,852,674	2,435.000	2,683,370	12,618,299	531.796,939	26.56
1890	6,016,525	6,633,219	2,653,000	2,923,606	13,025,637	563,693,232	27.99
1891	6,233,020	6,871,905	3,230.000	3,559,460	14.744,329	587,554,584	28.69
1892	6,816,323	7,514,996	3,228.000	3,557,256	14,998.633	593,497,904	30.22
1893	7,535,000	8,307,337	3,350,000	3,691,700	15,783,599	582,638,296	31.30
1894	8,629,000	9,509,158	4,311,000	4,750,722	18,197,510	610,487,368	27.97
1895	9,079,138	10,005,210	4,849,000	5,343,598	19,428,643	644,177,076	29.98
1896	9,229,000	10,170,358	5,019,690	5,531,698	20.866,748	664,001.718	28.92
1897	11,207,475	12,350,638	5,647,751	6,225.516	22.074,093	697,213,515	28.72
1898	12,307,450	13,562.810	6,761,301	7,572.657	24.797,873	738,129,608	29.80
1899	13,562,810	15,730,346	6,716,831	7,401,948	25.811,285	801,976,021	31.64
1900	16,151,557	17,799,016	7,429,457	8,187,262	27,684,964	846,041,848	31.88
1901	16,269.800	17,934,201	8,945,938	9,861,107	30,565,923	870,711,044	33.69
1902	15,259,674	17,090,835	9,701,682	10,691,254	37,907,163	889,474,934	33.91
1903	17,818,000	19,640,781	10,088,845	11,120,934	37,562,430	972,195,531	36.76
1904	[a] 19,318,370	21,294,639	10,772,240	11,874,240	43,332,409	983,385,935	35.78
1905	[a] 17,233,871	18,996,896	11,630,000	12,819,749	45,478,314	1,036,480,849	37.89
1906	21,613.800	23,857,961	12,980,103	14,307,968	47,898.532	1,117,848.143	37.05
1907	[a] 26,023,344	28,685,532	13,935,952	15,361,600	51,930,700	1,223,165,248	39.27
1908	[a] 25,059,100	27,622,646	14,825,363	16,341,998	58,276,756	1,169,071,160	35.57
1909			14,973,617	16,505,418	66,776,373	1,229,176,668	37.49
1910	[a] 22,650,000	24,967,095	15,681,324	17,285,523	71,445,828	1,279,020,792	39.22
1911	[a] 23,197,000	25,570,053			[b] 79,451,031	[c] 1,303,763,496	38.10

[a] These figures also include the production of Finland.
[b] For detailed statement see table on page 74.
[c] Latest available figures are used in making up totals for 1910.

COAL TRADE REVIEW.

It has been the practice in the preparation of the annual report on the production of coal to include reviews of the coal trade in some of the principal cities, and this custom has been followed in the present chapter. These reviews have been contributed chiefly by secretaries of chambers of commerce or other local authorities familiar with the coal trade of their respective communities. They will be found interesting in that they reflect the conditions which have influenced the markets and the bearing they have had upon production. Acknowledgment of the services rendered is gratefully made and recognition by name is given for each contribution.

The review of the coal trade in 1911 in the succeeding pages emphasizes the statement in the discussion of the statistics of production, namely, that outside of the iron and steel trade, the manufacturing industries of the country were maintained in a healthy condition, and the agricultural and transportation interests did not suffer from stagnation. Judged by the coal trade in 1911, notwithstanding the decrease of 5,000,000 tons in production, the country, was fairly prosperous. The continued low prices for bituminous coal in the keenly competitive States were probably the principal unfavorable feature of the year.

NEW YORK CITY

By Frederick Hobart, associate editor of the Engineering and Mining Journal.

It is, perhaps, advisable to repeat in this review some of the statements made in former years as to position of the coal trade of New York. No coal is delivered by rail directly in the city; it is brought to the railroad terminals on the western shore of the harbor and the Hudson. The coal docks are scattered all along the New Jersey shore from South Amboy on the outer harbor, to Edgewater, on the river, and deliveries are made from the docks to the wharves in the city and its adjacent territory by barges and car floats. In the traffic statements all the railroad coal docks are grouped under the general term "New York Harbor." In addition to the railroad coal something like 1,000,000 tons is received by water, this being chiefly New River and Pocahontas coal from Hampton Roads, with some Cumberland and Fairmont from Baltimore. A small quantity of anthracite also comes down the river from the Delaware & Hudson terminus at Rondout. The chief supplies of bituminous rail coal are drawn from the Clearfield, the Irwin, and the Somerset districts in Pennsylvania, the Cumberland in Maryland, and the Fairmont in West Virginia.

In 1911 there was no change of importance in the system of supplying coal to consumers in the city itself. In the borough of Manhattan there are no large storage yards, nor is there much individual storage of coal, owing to the high cost of land. Even where yearly contracts for supplies are made, the deliveries are made from day to day, and few consumers carry more than a few day's supply. The result of local conditions has been to consolidate the business gradually into the hands of a few large dealers who supply the general trade; while the innumerable flat and tenement dwellers obtain the coal they use in lots of 100 pounds or more at a time from small dealers who buy their coal from the large yards. A large proportion of the people do not buy coal directly at all, living and doing business in the large buildings which are heated from central plants.

The cost of distribution in New York is large. Retail prices are from $1.50 to $2 per ton above the tidewater rates where the coal is bought in lots of more than a ton. The small buyer has to pay at the rate of $10 or $12 a ton. Even with these differences it is claimed that there is little profit in the business. It must be admitted that the distribution is expensive and wasteful; but there is small prospect for improvement until we advance far enough to utilize the coal at or near the mines and to supply heat and power to New York in the form of gas or electric energy.

In the absence of definite statistics, which it seems impossible to secure, it is estimated that New York consumed in 1911 approximately 17,000,000 tons of coal, of which 12,250,000 tons were anthracite and 4,750,000 tons were bituminous. In addition to the city supply there was handled at the harbor shipping points about 10,600,000 tons shipped to New England ports—3,750,000 tons anthracite and 6,850,000 bituminous—and 4,500,000 tons bunkered or supplied to steamships. The bunker coal is practically all bituminous. This makes a total of approximately 16,000,000 tons anthracite and 16,100,000 bituminous, 32,100,000 tons in all, handled through New York Harbor. The city's consumption of anthracite is over 14 per cent of the total production. The increase in total consumption of coal over that of 1910 was not far from 1,000,000 tons.

Anthracite.—During a large part of 1911 the trade was rather uneventful, showing no marked changes. The main point was the evident increase in consumption. Month after month throughout 1911 an increase in production was reported, but the large output was readily absorbed and there did not seem at any time a surplus on the market. Not only were domestic sizes in the usual steady demand, but the market for steam sizes was generally good, and at times demand seemed to exceed the current supply.

Throughout January both domestic and steam sizes were generally well taken. For most of the month there were fair conditions for local distribution. Toward the close snow and stormy weather interfered with deliveries and there was rather a pressing demand for No. 2 buckwheat and barley. In February, however, there were some rumors of cut prices on steam sizes, but they could not be traced to any responsible source. In March, as is usually the case, the trade in the domestic sizes settled down into a weather market, and so continued through April. The spring was rather late, so that local demand continued good through March and well up into April.

In the latter part of March, of course, dealers generally held back from buying, in anticipation of the April discounts, but steam sizes, which are not affected by the discounts, remained strong and active. Owing to continued cold weather individual consumers were generally out of supplies and dealers' yards were bare of stocks when April came, so that the month saw a spurt of buying of domestic sizes, and business was good throughout.

In May buying was good and the trade was slow in settling down to a summer basis. Steam sizes continued to move freely. Coastwise trade began to be a factor but opened rather quietly. In June the local trade settled down to its usual summer gait on domestic sizes, the steam sizes being still in good demand. The Lake trade began to be a factor, shipments to Buffalo increasing as those to tidewater fell off. A little shortage in buckwheat developed and in some cases premiums of 5 or 10 cents were paid for that size.

July holidays interfered a little with business, and trade was slow for the first half of the month. Later it improved, and toward the end of the month there was a little rush to save the discount.

In August business was rather dull. Coal moved steadily on contract, though new business was slow. Some operators and dealers were accused of cutting prices, but the reports could not be substantiated.

In September business began to improve in the larger sizes. The steam-coal trade was good, and about the middle of the month there was again a shortage in buckwheat and rice, for which small premiums were paid.

October and November were uneventful months, with good steady buying and regular movements on contract. Steam-coal demand remained strong. In December reports of a probable strike at the termination of the miners' agreement on March 31 began to be generally accepted, and there was some movement among the larger dealers and consumers to put in stocks in anticipation of a shutdown. The three months remaining before a possible strike, however, prevented this demand from becoming a very strong factor, and indeed the coal companies were hardly prepared to meet it when it developed. In spite of the increased production the shipments had been freely taken, and there was little surplus in the storage yards. The weather had little effect on the market, as it continued mild for the most part and did not until the last week give promise of the severe cold which followed in the opening months of the new year.

Prices of domestic sizes were unchanged from 1911. The schedule remained $4.75 per ton for lump, $5 for egg and stove, and $5.25 for chestnut, all f. o. b. New York Harbor. Advances of 10 to 20 cents are charged for a few favorite special coals. The usual system of summer discounts was allowed, the reduction from the schedule being 50 cents per ton in April, 40 cents in May, 30 cents in June, 20 cents in July, and 10 cents in August, the full schedule being resumed on September 1. For steam sizes quotations did not vary greatly.

In January pea coal was quoted at $3 to $3.25 per ton; buckwheat, $2.40 to $2.75; rice or No. 2 buckwheat, $1.75 to $2.25; barley $1.40 to $1.55; all according to quality, f. o. b. New York Harbor. The lower range of prices is generally paid for washery and individual shipments.

In June the quotations were off slightly, $3 to $3.25 being named for pea, $2.25 to $2.70 for buckwheat, $1.75 to $2.15 for No. 2 buckwheat or rice, and $1.35 to $1.50 for barley. The market closed in December rather firmer for the smaller sizes. Pea remained $3 to $3.25, but $2.45 to $2.90 was asked for buckwheat, $1.80 to $2.25 for rice, and $1.45 to $1.60 for barley. A large proportion of the steam sizes is sold under yearly contracts, being taken by the public utilities companies—street railroads, electric lighting companies, etc.—and other large consumers. This rather steadies the market and prevents any large fluctuations.

The increased consumption in 1911 was due to several causes. The normal increase in the population supplied from the New York market was one cause, of course; the late, cold spring was another; and a third was the gain in manufacturing and building activity over the preceding year. Minor causes for greater consumption of steam coals are found in the larger business of the elevated and subway trolley lines, and in the extensions of the Long Island and Pennsylvania electric traction systems.

Bituminous.—The year opened with the New York market rather dull, notwithstanding the fact that supplies of coal at tidewater were low, owing to short supply of cars and slow transportation. Coastwise trade was very light, as usual at that season. Contract deliveries were not being urged, and there was little spot buying. As January went on harbor trade improved and there was a better movement on contract. The range of prices in January was about $2.60 per ton for a fair grade of steam coal, with lower grades running down to $2.35 and better sorts up to $2.90, all f. o. b. New York harbor. Gas coals were quoted at $1 to $1.10 for ¾-inch, 95 cents to $1 for run-of-mine, and 70 cents for slack, all at mines. Current demand was chiefly for the lower-priced coals. Toward the end of the month there was some talk about yearly contracts, but the general disposition was to postpone closing them as long as possible. The West Virginia operators, however, began to put in their work and some low offers were noted.

Through February trade continued to be quiet. Car supply and transportation improved and there was a better supply of coal at tide, but no surplus evident. Prices continued about at the January range. Conditions in March were much the same, except that about the middle of the month surplus supplies of coal at tide began to be in evidence, and some lots of low grade coal were offered as low as $2 to avoid demurrage. West Virginia operators became urgent about contracts and offered Pocahontas and New River at $2.65 to $2.70 f. o. b. Lambert Point and Newport News. By the end of the month the cheap demurrage lots were pretty well cleaned up and the market was in better shape. Contract making progressed slowly, though many yearly contracts expired with the month.

In April there was some activity in coastwise trade and New England buyers began to come into the market. Harbor trade showed an improvement. Prices were without quotable change, but were more firmly held. May opened with trade quiet and prices a shade lower. Good steam coal brought about $2.50, with lower grades down to $2.30 and better up to $2.85. Gas coals were firmer. The market was disturbed by reports that West Virginia coal had been offered at very low prices. Contract making continued to drag along slowly but toward the end of the month quite a number of contracts were closed, generally at about 1910 prices.

June showed a better feeling in the trade and a more hopeful disposition. Prices, however, remained about the same. Production seemed to be pretty well regulated to consumption and there was no surplus coal at tide. In fact receipts were rather slow, as the Lake trade began to take coal from the seaboard market. Through July and August the trade continued fairly steady and on a good scale for midsummer, but with no improvement in prices. The only incident was a surplus of gas slack in August which sold at all sorts of prices. This was due to the large shipments of Lake coal, that trade taking lump altogether.

In September the trade began to improve. Shipments on contract were better and harbor trade more active. Prices became firmer. An average steam coal brought \$2.60 f. o. b. New York harbor, with better grades up to \$2.90 and lower qualities down to \$2.40. Gas coals were firmer, bringing \$1.15 to \$1.20 for ¾-inch at mine, and \$1.05 to \$1.10 for run-of-mine. Slack, however, was still low.

Through October the market remained steady, but with no notable change. In November the tidewater shipments were heavy and there was a surplus supply, which led to a weakening of 5 or 10 cents in prices. In December there was a decided improvement in the market. Demand increased and winter conditions began to prevail. Car supply was not so good and transportation was slower. Supplies at tide were not overplentiful and prices became a little firmer. There was rather a shortage of gas slack, and prices went up almost to a parity with run of mine. The closing prices, f. o. b. New York Harbor, were \$2.40 for West Virginia and \$2.65 for fair grade Pennsylvania steam, with lower grades down to \$2.35 and better up to \$2.90 per ton.

There was no special spurt in the trade at any time during the year, but the volume of business was, on the whole, better than in 1910. Prices were not high, but maintained a fair level through the year, which will go on record as fully up to the average, if not a little above it.

Coastwise and harbor trade.—Conditions in the coastwise trade did not vary in any considerable degree from former years. The greater part of the anthracite shipped from New York to New England and the other ports is carried in steam colliers and in barges owned chiefly by the large companies, the barges having the preference. Fleets of these barges towed by sea-going tugs go along the coast as far as the Maine ports. The worst risk in this kind of trade is the breaking loose of barges from the tows in stormy weather. In this case they run a large chance of wreck, as the tug is generally unable to leave the rest of its convoy to recover a single barge. The result is a considerable loss each year in barges and coal, with some loss of life. In spite of this the cheapness of the system militates against its abandonment and against the increased use of the steam collier, though the latter is safer and more manageable in heavy weather. To the ports on Long Island Sound and even around Point Judith to Providence, Fall River, and New Bedford the risk to tows is comparatively small; but where the voyage is extended around Cape Cod and to the Maine coast it is considerable.

In the bituminous trade the sailing vessel still holds an important place. There are two classes of boats in this trade, the large schooners which ply to the more open ports and the smaller and lighter draft vessels which can reach the docks at the Sound ports and at what are known as the shoal-water ports on the eastern coast and on Kennebec and Penobscot rivers. The coastwise shipments are made entirely from the railroad terminals on the harbor and the west shore of Hudson River.

The harbor trade is entirely a barge trade, carrying coal from the railroad docks to the wharves of the city itself and to adjacent points on the Hudson, East River, and Long Island Sound. It includes also a considerable tonnage carried in cars without transshipment on car floats to the terminals of the Long Island, the New Haven, and the New York Central roads.

The greater part of the bunker or steamship coal is also handled from the railroad docks by barges.

If vessel owners are to be believed, 1911 was not a good year, but in view of the large trade there may be room for various opinions on this point. It was at least up to former years and probably better than either 1909 or 1910. Unloading conditions at the Sound ports have been improved during the last two years, and there was less complaint of long delays at the ports than ever before. There was an uneven distribution of the trade, which was slack in the early part of the year, with a rush in the fall when the shoal-water ports were hustling for supplies before they should be closed by ice; but this is a condition which always has prevailed and probably always will prevail.

January opened with bad weather and a scarcity of boats to carry what trade was offering. As high as 90 cents to $1 per ton was paid from New York Harbor to Boston and Portland, with 45 to 55 cents to Sound ports. It should be understood that 10 or 15 cents is to be added to the Portland rates for the shoal-water or towage ports, and that in the Sound rates the higher rate is to Providence, the lower to New Haven, New London, and the nearer ports.

Later in January the weather was moderate and boats were in better supply. The rates gradually declined to 65 to 75 cents to points around Cape Cod and 35 to 45 cents to the Sound. Barge rates on harbor trade also declined from 30 cents, which had been asked in January, to 15 to 18 cents, the normal rate. Early in February there was a stormy period during which rates were irregular, vessel owners being unwilling to let their boats go out. By March 1, however, the trade had become quiet and owners were hunting charters, with the result that rates dropped to 55 to 65 cents to points around Cape Cod. As the New England trade began to open, rates stiffened, and through April and May the going rates ran about 65 to 75 cents to points around Cape Cod and 30 to 40 cents to the Sound. In June vessels were plenty and rates lower, 55 to 65 cents being charged around the Cape, 25 to 35 cents to the Sound. These rates held through July and August, but by the middle of September the shoalwater port rush was on, and there was an advance of 10 cents all around. This held until the middle of November, when there was a sharp advance, 80 to 90 cents being asked to Boston and Portland, 35 to 45 cents to Sound ports. Early in December there was rough weather and rates took another jump, $1 to $1.10 being asked for charters around the Cape and 40 to 50 cents to Sound ports. Through December the weather was bad and boats scarce; by the end of the month shippers were paying $1.05 to $1.15 per ton to Boston and Portland, and 45 to 55 cents to Sound ports. These were the highest rates of the year.

Coastwise shipments from New York harbor ports for five years past are reported as follows:

Shipments of coal from New York harbor points, 1907–1911, in long tons.

	1907	1908	1909	1910	1911
Anthracite	16,753,914	15,069,981	14,418,292	13,991,426	14,651,401
Bituminous	11,691,101	10,247,014	10,549,974	10,431,636	10,749,988
Total	28,445,015	25,316,995	24,968,266	24,423,062	25,401,389

In 1911, as compared with 1910, there was an increase in shipments of 659,975 tons in anthracite and of 318,352 tons in bituminous; a total gain of 978,329 tons, or 4 per cent. From 60 to 65 per cent of these shipments are barge traffic to city and adjacent wharves; the remainder is chiefly to New England. There are practically no exports to foreign countries from New York, unless the bunker coal is counted as exported.

PHILADELPHIA, PA.

By SAMUEL R. KIRKPATRICK, Land Title Building.

The year 1911 made another record one in anthracite shipments. With the improved facilities for mining and the better delivery of cars the coal companies seem to be able to get out as much coal as occasion requires. A few years ago to be able to mine 5,000,000 long tons in any one month was enough to cause comment. Now this output is of almost monthly occurrence and many months show nearly 6,000,000 tons. An incentive in the latter part of 1911 to mine as much coal as the miners could get out was furnished by the apprehension of a strike in the following year. It was feared that the operators would not agree to the demands of the miners and that the mines would be shut down for at least two months. All the coal companies began early in the summer to stock up, it being their intention to have a large supply on hand in the event of a strike. The cold weather, however, created a demand for all sizes of anthracite coal, especially the domestic ones. There were few dull weeks and it is safe to assert that more consumers stocked up their coal bins during the summer and early fall than has ever been the case before. Apprehension of trouble with the miners affected the householder and manufacturer as well as the operators, and they hastened to get enough coal in their bins to tide them over any labor difficulty.

The coal strikes abroad had a good effect on bituminous coal here and many thousand tons of soft coal were exported. The net gain for the year was small but it would have been considerably less if the urgent demand had not sprung up for our coal.

The large coal companies maintained prices during the whole year, but this can not be said of the individual operators. These operators have not the facilities that the large coal companies have for the storage of any large amount of coal and when their supply becomes large they are forced to find a market for their output. This at times is difficult to accomplish and the consequence is that prices are cut. In the early summer some of the independent operators were selling their production at a reduction of from 25 to 35 cents a ton below the circular prices.

The large coal companies claim that the demand for chestnut sizes was greater than the supply and to equalize this demand this size was excepted from the usual spring reduction. In March the price at the mines for chestnut sizes was $3.75, an advance of 25 cents over 1910. Ten cents a month was added until fifty cents had been reached. There was also an advance in the contract price of rice coal of 25 cents. The users of this size and buckwheat were notified in December that on January 1, 1912, the price on these sizes would be further advanced.

The coal companies put into effect the early spring circular, which was a reduction of 50 cents from the prices in effect prior to April 1.

This reduction was restored by adding 10 cents each month until the regular circular prices were obtained.

All the coal companies endeavored to stock up during the summer and fall months. It was believed that from 10,000,000 to 15,000,000 tons might be put aside, but the cold winter and the urgent demand for all sizes of anthracite caused the stocks to be drawn upon so that the amount in storage was considerably less than the companies had expected.

Every endeavor on the part of the large coal companies to induce the larger consumption of large stove and other large domestic sizes was made. The price of chestnut size was advanced, but it did not lessen the demand. Pea coal is much higher than it was a few years ago and even buckwheat is being introduced into the household. There is a steady demand for bituminous coal in this city. Many of the large manufacturing plants that were forced to depend on this fuel during the anthracite coal strike in 1902 have never gone back and unless some legislation is enacted by the council of this city it is believed that many of the plants will use more soft coal than ever before.

There is some prospect of legislation in regard to the free burning of soft coal. At the present time the smokestack must be a certain height. The Pennsylvania Railroad Co. has been compelled to lessen the firing of its locomotives in West Philadelphia yards and it is said that more stringent means are to be adopted so that the "smoke nuisance" can be abated.

The shipments for export showed a falling off in the amount of anthracite and a slight loss in bituminous. The shipments of the latter fuel during the latter part of the year were extremely heavy. The shipments for coastwise and harbor trade showed a slight gain both in anthracite and bituminous. The anthracite shipments were 1,933,359 long tons as against 1,606,373 tons in 1910. The bituminous shipments for the same time amounted to 4,287,150 tons as against 4,236,476 tons.

The following table shows the average range of retail prices of anthracite and bituminous coal during 1911 by months:

Average prices for anthracite and bituminous coal at Philadelphia in 1911, by months, per long tons.

Month.	Chestnut.	Prepared sizes.	Pea.	Buckwheat.	Rice.	Bituminous.
January	$6.75-$7.00	$6.75-$7.00	$4.75	$3.35-$3.75	$2.75-$3.10	$3.75-$4.00
February	6.75- 7.00	6.75- 7.00	4.75	3.35- 3.75	2.75- 3.10	3.75- 4.00
March	7.00- 7.25	6.75- 7.00	4.75	3.35- 3.75	2.75- 3.10	3.75- 4.00
April	6.75- 7.25	6.00- 6.50	$4.25- 4.50	3.20- 3.50	2.75- 3.10	3.75- 4.00
May	6.75- 7.00	6.25- 6.50	4.25- 4.50	3.20- 3.50	2.75- 3.10	3.50- 4.00
June	6.75- 7.00	6.25- 6.50	4.25- 4.50	3.25- 3.50	2.50- 3.00	3.00- 4.00
July	6.75- 7.00	6.25- 6.60	4.00- 4.50	3.25- 3.50	2.50- 3.00	3.00- 4.00
August	6.75- 7.00	6.25- 6.50	4.00- 4.50	3.20- 3.75	2.50- 3.10	3.00- 4.00
September	6.75- 7.00	6.40- 6.75	4.25- 4.50	3.35- 3.75	2.50- 3.10	3.25- 4.00
October	7.00- 7.25	6.40- 6.75	4.25- 4.75	3.35- 3.75	2.50- 3.10	3.25- 4.00
November	7.00- 7.25	6.50- 6.75	4.25- 4.75	3.35- 3.75	2.50- 3.10	3.40- 4.00
December	7.00- 7.25	6.50- 6.75	4.50- 4.75	3.35- 3.75	2.50- 3.10	3.50- 4.00

The production of anthracite coal during 1911 was the largest in the history of anthracite mining. The following table shows the shipments of 1911 as compared with 1910:

Anthracite shipments 1910 and 1911, by months, in long tons.

Month.	1910	1911	Month.	1910	1911
January	5,306,618	5,904,117	August	4,996,044	5,531,796
February	5,031,784	5,070,948	September	4,967,516	5,730,935
March	5,174,166	5,996,894	October	5,622,095	6,269,175
April	6,224,396	5,804,915	November	6,071,746	6,193,314
May	5,679,661	6,317,352	December	6,231,578	6,115,427
June	5,398,123	6,[illegible]15,357			
July	4,202,059	4,804,065	Total	64,905,786	69,954,299

There was a slight decrease in the shipments of anthracite coal for export. Cuba and Canada took the bulk of hard coal, 28,291 tons, valued at $121,067, being sent to Cuba and 16,412 tons, valued at $73,119, to Canada. To Newfoundland 5,887 tons of anthracite were forwarded, valued at $26,566. The total value of anthracite shipments for export amounted to $230,593. The shipments of bituminous coal for export amounted to 791,506 tons, valued at $2,197,725. Cuba, Italy, and Mexico consumed the most of this coal.

Freight rates remained the same throughout the year. The following table shows the rates to Philadelphia from the mines:

Freight rates per long ton on anthracite from coal regions to Philadelphia, Pa.

Region.	Prepared sizes.	Pea.	Buckwheat.
Schuylkill	$1.70	$1.40	$1.25
Lehigh	1.75	1.45	1.30
Wyoming	1.80	1.50	1.35

Through the courtesy of the officers of the Pennsylvania Railroad Co., the Philadelphia & Reading Railway Co., the Lehigh Coal & Navigation Co., and the Baltimore & Ohio Railroad Co., data have been furnished from which the following table has been compiled. It shows the distribution of coal at Philadelphia for the export trade, the coastwise and harbor trade, and the Philadelphia local trade:

Distribution of coal at Philadelphia, Pa., in 1910 and 1911, in long tons.

Destination.	1910		1911	
	Anthracite.	Bituminous.	Anthracite.	Bituminous.
Export	72,733	794,015	52,984	791,506
Coastwise and harbor	1,606,373	4,236,476	1,933,359	4,287,150
Local	4,160,953	2,390,658	4,194,915	2,625,505
Total	5,840,059	7,421,149	6,181,258	7,704,161

The price circular of the Philadelphia & Reading Coal & Iron Co., which is the same as that of other companies, is as follows:

Circular prices for anthracite coal at the mines in 1910 and 1911.

Size.	1910		1911	
	April.	September.	April.	September.
Lump	$3.50	$3.50	$3.50	$3.50
Steamboat	3.00	3.00	3.00	3.00
Broken	3.00	3.50	3.00	3.50
Egg	3.25	3.75	3.25	3.75
Stove	3.25	3.75	3.25	3.75
Chestnut	3.25	3.75	3.50	4.00
Pea	2.00	2.00	2.00	2.00
Buckwheat	1.50	1.50	1.50	1.50

BOSTON, MASS.

By ROBERT S. COFFIN, secretary of the committee on fuel supply, Boston Chamber of Commerce.

Receipts and shipments.—The receipts of coal at the port of Boston for the year 1911 were the largest for any one year since the records of this tonnage have been kept. The aggregate tonnage of anthracite and bituminous amounted to 6,418,031 long tons as against 6,230,022 tons in 1910, which had exceeded all previous years by approximately half a million tons. Of the tonnage for 1911, 1,982,940 tons were anthracite, 4,171,230 tons were bituminous, and 263,861 tons were foreign bituminous. This was an increase of 156,776 tons of anthracite and 63,936 tons of bituminous and a decrease of 32,703 tons of foreign bituminous. The greater part of the total increase for the year was in the receipts of anthracite coal. This was due entirely to the precautions which the dealers were taking in anticipation of the termination of the three-year agreement between the anthracite mine operators and the miners. It was feared that there would be a suspension of operations before a new contract could be agreed upon, and the dealers, in order to protect themselves against a strike, had accumulated a larger supply of coal than they otherwise would have done.

In addition to the receipts of coal for local consumption, Boston is the distributing center for a considerable tonnage of coal which is forwarded over the railroads to interior New England points. In 1911, 246,610 tons, or about 12 per cent, of the anthracite tonnage, and 1,235,228 tons, or about 30 per cent of the bituminous tonnage, received at Boston, was forwarded to interior New England points. The net receipts for local consumption amounted to 1,736,330 tons of anthracite and 3,199,863 tons of bituminous coal.

The following table shows the receipts both of anthracite and of bituminous coal at Boston, by months, for 1911; the quantity forwarded to interior points; the net receipts for local consumption; and the totals for 1911 as compared with the three preceding years:

Receipts and shipments of coal at and from Boston in 1911, by months, in long tons.

Month.	Receipts from all points.		Shipments to New England points.		Net receipts (for local consumption).	
	Anthracite.	Bituminous.	Anthracite.	Bituminous.	Anthracite.	Bituminous.
January	142,675	350,773	21,896	98,683	120,779	252,090
February	113,010	335,291	19,471	83,125	93,539	252,166
March	154,078	349,400	17,486	117,615	136,592	231,785
April	198,138	381,450	27,440	97,013	170,698	284,437
May	185,257	379,455	19,642	85,339	165,615	294,116
June	170,311	355,758	16,605	105,374	153,706	250,384
July	170,713	377,176	20,004	98,344	150,709	278,832
August	157,927	395,597	18,226	108,092	139,701	287,505
September	133,173	345,997	21,781	98,967	111,392	247,030
October	203,700	348,348	23,182	118,394	180,518	229,954
November	155,322	402,531	19,560	118,038	135,762	284,493
December	193,636	413,315	21,317	106,244	177,319	307,071
Total, 1911	1,932,940	4,435,091	246,610	1,235,228	1,736,330	3,199,863
1910	1,826,164	4,403,858	241,641	743,635	1,584,523	3,660,223
1909	1,706,659	3,723,308	244,345	1,139,278	1,462,314	2,584,030
1908	1,776,401	3,673,633	255,984	1,130,674	1,520,417	2,542,962

Below is given a table showing the receipts of coal at Boston for the last eight years in long tons. It is interesting to note that during that period the receipts of bituminous coal have increased nearly 100 per cent and that practically all of this tonnage is waterborne, there being no increase in the receipts by rail. On the other hand, the receipts of anthracite coal have shown a gradual falling off during the same period. This decrease in the consumption of anthracite is attributed to the increasing consumption of coke, gas, and electricity for domestic use.

Receipts of coal at Boston, Mass., for eight years, in long tons.

Year.	Domestic.				Foreign.	Total.
	By water.		By rail.			
	Anthracite.	Bituminous.	Anthracite.	Bituminous.	Bituminous.	
1904	1,961,785	2,397,885	40,994	117,605	550,383	5,068,652
1905	1,941,478	2,757,186	35,920	41,104	608,471	5,384,159
1906	1,630,674	2,772,593	29,005	87,251	658,072	5,177,595
1907	2,016,252	3,196,057	37,036	89,927	545,652	5,884,924
1908	1,733,112	3,240,562	43,289	62,367	370,709	5,450,039
1909	1,668,126	3,393,423	38,533	101,588	228,297	5,429,967
1910	1,760,883	3,954,251	65,281	153,043	296,564	6,230,022
1911	1,881,767	4,101,745	101,173	69,485	263,861	6,418,031

Anthracite.—The retail prices of anthracite maintained a higher level throughout the year than in 1910. The summer prices did not go into effect until April 17, when a reduction of 50 cents per ton from the winter prices was made. This, however, was 25 cents per ton higher than the summer prices for the preceding year on all kinds, with the exception of furnace, egg, and pea. On July 9 the price on all sizes was advanced 25 cents per ton, and a further increase of 25 cents per ton on all sizes was made on September 1. This latter advance included both pea and furnace, which had been advanced only 25 cents per ton in 1910. This made the fall prices in 1911 25 cents per ton higher than in 1910 on all sizes, with the exception of pea.

Retail prices, per short ton, of anthracite at Boston in 1911, by kinds.

Kind.	Apr. 1.	Apr. 17.	July 9.	Sept. 1.
Furnace	$6.75	$6.25	$6.50	$6.75
Egg	7.25	6.75	7.00	7.25
Stove	7.50	7.00	7.25	7.50
Nut	7.50	7.00	7.25	7.50
Pea	5.75	5.25	5.50	5.75
Shamokin	7.75	7.25	7.50	7.75
Franklin	8.75	8.25	8.50	8.75

Foreign coal.—The only receipts of foreign coal were from the bituminous mines of the Dominion Coal Co. in Cape Breton. This coal was consigned to the by-product coking plant at Everett, a suburb of Boston. Practically no Canadian coal is used in Boston for raising steam.

Coastwise freight rates.—The coastwise freight rates in 1911 were much higher than in 1910. From Hampton Roads the minimum rate in 1911 was 55 cents per ton and the maximum rate was $1.30 per ton, as compared with rates ranging from 50 cents to 80 cents per ton in 1910; the rates from Philadelphia in 1911 ranged from 55 cents to $1.25 per ton, as compared with rates ranging from 50 cents to 90 cents in 1910; from Baltimore the rates in 1911 ranged from 60 cents to $1.35 per ton, as against 60 cents and 90 cents in 1910.

Coal freights to Boston during 1910 and 1911.

1910.

From—	Minimum.		Maximum.	
	Rate.	Date.	Rate.	Date.
New York	[a] $0.50–$0.55		$0.85	Dec. 15.
Philadelphia	.50	Aug. 15	.90	Dec. 10–15.
Baltimore	.60	Aug. 5–25	.90	Dec. 15.
Norfolk and Newport News	.50	June 15–Dec. 15	$0.75– 0.80	Dec. 15–25.

1911.

From—	Minimum rate.	Minimum date.	Maximum rate.	Maximum date.
New York	[a] $0.50–$0.55		$1.00	Dec. 30.
Philadelphia	.55	Aug. 15–31	1.25	Nov. 30.
Baltimore	.60	Aug. 15–Sept. 10	1.35	Dec. 1–15.
Norfolk and Newport News	.55	May 30–Sept. 15	$1.25– 1.30	Nov. 20–Dec. 10.

[a] Fifty to fifty-five cents was season rate on anthracite coal-carrying railroad transportation from New York and 75 cents from Philadelphia. Sixty cents was the minimum rate on sail (sailing vessels) tonnage from New York to Boston.

The coal trade was quite normal during the year 1911 and presents little which is worthy of comment. Some of the large coal-consuming industries accumulated large supplies of coal in anticipation of a strike by the miners at the expiration of the contracts between the mine operators and the miners, both in the anthracite and the bituminous coal fields on March 31, 1912. During the year 5 modern coal steamers were added to Boston's fleet of colliers, making in all 12 modern coal steamers engaged exclusively in the coal trade between Boston and the southern coal ports, with a total carrying capacity of about 72,000 tons. In this connection, it may be interesting to note that during the year 1911 about 2,042,000 tons, or practically 50 per cent of the bituminous tonnage received at Boston, was transported in steamers; and the other 50 per cent, which was conveyed in barges and schooners, was about equally divided between them. This indicates the transition which has taken place in the methods of transporting water-borne coal. The modern coal steamer is rapidly displacing the sailing vessel to the larger coal ports. This is quite natural in that it is becoming more and more essential to have a constant and well regulated supply of coal arriving at a large port, in order to obtain the greatest efficiency in the operation of railways, discharging plants, and vessels.

BALTIMORE, MD.

By SAMUEL G. WILMER, financial editor of the Manufacturers' Record.

There was a large increase in the volume of the coal business at Baltimore during 1911, the receipts of bituminous alone reaching a total of 5,968,151 long tons, or 884,478 tons, more than in 1910. The total receipts of both bituminous and anthracite were nearly a million tons greater, the exact increase being 956,374 tons. The coastwise shipments were also much larger, totaling 4,412,659 tons, which was an increase of 248,946 tons over 1910. These include coastwise shipments of bituminous 4,135,893 tons, an increase of 244,875 tons, and of anthracite 276,766 tons, an increase of 4,071 tons. Exports of bituminous were 479,096 tons, or 14,320 tons less, but the exports of anthracite, although small, being only 4,525 tons, display an increase of 1,477 tons. Receipts of coke were 194,666 short tons, a falling off of 38,835 tons, as compared with the next preceding year, but the exports of this fuel were 98,285 tons, an increase of 51,798 tons. This is an advance of more than 100 per cent in volume of coke exports during the year, although the total did not reach the record of 1908; the latter excepted it was, however, greater than in any other year.

Thus 1911 was a banner year for the coal business at this port, but, in spite of the fact that so much coal was sold, prices for the medium and lower grades of bituminous were pronounced unsatisfacory, some, at least; selling—it is asserted in the trade—for less than cost. The higher grades commanded good prices, and the business therein was, consequently, gratifying.

The anthracite trade was very good and the demand steady. Prices were sustained; and both receipts and shipments display the enlargement of the business in this variety of fuel, very little of which is used at Baltimore for anything but household purposes.

The table following exhibits the receipts and shipments of both coal and coke at Baltimore, including coal and coke received and used by the Maryland Steel Co. and the Central Foundry Co., both of which, although not inside the corporate limits, are so near at hand as to demand consideration in any remarks concerning the coal trade of this city.

Receipts and shipments of coal and coke at Baltimore, Md., 1910–1911, in long tons.

Kind.	1910			1911		
	Receipts.	Tidewater shipments.		Receipts.	Tidewater shipments.	
		Coastwise.	Exports.		Coastwise.	Exports.
Bituminous	5,083,673	[a] 3,891,018	493,416	5,968.151	[a] 4,135,893	479,096
Anthracite	809,578	272,695	3,048	881,474	276,766	4,525
Total	5,893,251	4,163,713	496,464	6,849,625	4,412,659	483,621
Coke (short tons)	233,501	....	46,487	194,666	....	98,285

[a] Includes shipments to points on Chesapeake Bay and in Baltimore Harbor.

Coastwise shipments of coal from Baltimore, 1903–1911, in long tons.

Year.	Anthracite.	Bituminous.	Total.
1903	....	....	1,731,896
1904	238,728	2,064,060	2,302,788
1905	252,568	2,832,321	3,084,889
1906	238,162	3,176,710	3,414,872
1907	266,062	3,804,066	4,070,128
1908	251,739	3,704,851	3,956,590
1909	235,233	3,344,225	3,579,458
1910	272,695	3,891,018	4,163,713
1911	276,766	4,135,893	4,412,659

The exports of bituminous coal and coke from Baltimore during 1911 were together larger than those of any year except 1907. The following table shows in detail the exports for the year, month by month, and also the total exports during each of the six next preceding years:

Exports of bituminous coal and coke from Baltimore in 1911, by months, in long tons.

Month.	Bituminous coal.	Coke.
January	40,253	7,278
February	30,452	6,026
March	37,185	10,364
April	34,641	10,418
May	56,215	6,020
June	37,731	10,837
July	28,525	5,061
August	40,346	10,942
September	36,582	11,153
October	49,710	5,652
November	42,222	3,736
December	45,234	10,798
Total 1911	479,096	98,285
1910	493,416	46,847
1909	332,016	50,446
1908	347,489	105,317
1907	559,880	77,822
1906	458,203	69,230
1905	341,107	32,954

Concerning the use of coal and coke at the plants of the Maryland Steel Co. at Sparrows Point, Md., and of the Central Foundry Co. at Dundalk (post office St. Helena), Md., the figures here presented are official, as follows:

Maryland Steel Co.—Consumption of bituminous coal during 1911 amounted to 599,805 long tons. Coke purchased amounted to 55,782 long tons. There was manufactured by the company in its by-product coke ovens 300,266 long tons of coke, which was also consumed. As stated in the review covering 1910, the company consumed during that year 617,759 long tons of bituminous coal and 137,499 long tons of coke, the latter being in addition to coke of the company's own manufacture which was used.

Central Foundry Co.—This plant consumed during 1911 a total of 2,175 tons of bituminous coal and 1,780 tons of coke, as compared with 4,036 tons and 3,760 tons, respectively, during 1910.

Acknowledgment is due to officials of the Baltimore & Ohio, the Pennsylvania, and the Western Maryland railroad companies, and also to the Maryland Steel Co. and the Central Foundry Co. for statistics used in the compilation of the tables.

NORFOLK AND NEWPORT NEWS, VA.

The well-known New River and Pocahontas coals mined in the southern part of West Virginia and in the extreme southwestern counties of Virginia reach tidewater at Hampton Roads over the Chesapeake & Ohio, the Norfolk & Western, and the Virginian railways. The last-mentioned road was opened for traffic in April, 1909, and carried during the remaining nine months of the year 241,644 long tons of coal. In 1910 the Virginian Railway carried 1,147,077 tons, and in 1911 it carried 2,012,483 tons. The Norfolk & Western and the Virginian roads have terminals at Lambert Point and Sewall Point, respectively, on the south side of "The Roads" near Norfolk, and the Chesapeake & Ohio terminals are on the north side at Newport News.

Next to New York Harbor there is more coal handled at Hampton Roads than at any other seaport in the United States. The quantity loaded in 1911, including bunker coal, exceeded all previous records, and amounted to 10,326,135 long tons against 9,597,574 tons in 1910. The increase in 1911 was 728,561 tons, or nearly 8 per cent. The gain in 1911 was altogether in the quantity of coal handled over the Sewall Point piers from the Virginian Railway, though shipments from the Chesapeake & Ohio at Newport News and from the Norfolk & Western at Lambert Point held up well. Shipments of coal from points on the Virginian increased 865,406 tons, from Norfolk & Western mines they decreased 117,551 tons, and from Chesapeake & Ohio mines they were within 19,294 tons of the 1910 record.

Of the total shipments in 1911 of 10,326,135 long tons of coal 7,278,729 tons were sent coastwise, chiefly to New England ports, 1,925,741 tons were exported, and 1,121,665 tons were for bunker trade.

For the figures included in the table following the writer is indebted to the following officials, namely: Messrs. Joseph W. Coxe, comptroller, Norfolk & Western Railway, at Roanoke; W. F. Hope, superintendent coal terminals, Virginian Railway, at Sewall Point, Norfolk; E. D. Hotchkiss, general freight agent, Chesapeake & Ohio Railway, at Richmond.

Coal receipts at Hampton Roads in 1911, in long tons.

Destination.	Norfolk & Western Ry.	Chesapeake & Ohio Ry.	Virginian Ry.	Total.
Coastwise	2,494,165	3,168,864	1,615,700	7,278,729
Export	915,651	859,055	151,035	1,925,741
Bunker	513,282	362,635	245,748	1,121,665
Total	3,923,098	4,390,554	2,012,483	10,326,135

The monthly shipments over the Virginian Railway, as reported by Mr. Hope, were as follows:

Statement of coal dumped over Sewall Point Pier, 1911, by months, in long tons.

Month.	Coastwise.	Export.	Bunker.	Total.
January	100,740	9,761	21,922	132,423
February	100,132	5,121	16,092	121,345
March	124,105	....	16,503	140,608
April	107,872	4,091	11,882	123,845
May	127,516	13,102	14,527	155,145
June	141,579	7,463	20,341	169,383
July	139,228	14,899	15,849	169,976
August	121,667	25,703	19,058	166,428
September	148,357	14,691	19,334	182,382
October	179,986	14,141	28,411	222,538
November	144,678	16,757	31,980	193,415
December	179,840	25,306	29,849	234,995
Total	1,615,700	151,035	245,748	2,012,483

The total shipments from Virginia and southern West Virginia coal mines to Hampton Roads during the last five years have been as follows:

Shipments of coal to Hampton Roads, 1907–1911, in long tons.

Year.	Norfolk & Western Ry. to Lambert Point.	Chesapeake & Ohio Ry. to Newport News.	Virginian Ry. to Sewall Point.
1907	3,221,010	3,887,804	....
1908	2,401,223	3,997,121	....
1909	3,228,854	4,985,426	241,64
1910	4,040,649	4,409,848	1,147,07
1911	3,923,098	4,390,554	2,012,48

PITTSBURGH, PA.

More fuel is consumed in the city of Pittsburgh and its immediat vicinity, and more coal is shipped to and through the Pittsburg district, than in any other district in the world. With a populatio of about one-ninth of that of Greater New York (533,905 to 4,766,88 in 1910) the consumption of coal alone in Pittsburgh is nearly equa to that of the much larger city. Greater New York consumed i 1911 approximately 17,000,000 long tons (about 19,000,000 shor tons) and Pittsburgh used about 16,500,000 short tons. But Pitts burgh consumes several million tons of coke and considerable quantities of natural gas, which, added to the coal consumption, gives that city a good lead over New York as a fuel consumer. In the quantity of coal handled the comparisons are still more striking, Pittsburgh's business exceeding that of New York by nearly 50 per cent. In 1911 the total coal traffic in New York Harbor, including the city consumption, the transshipments to New England and up-river points, and the bunker and export trade amounted to approximately 36,000,000 short tons, whereas the coal traffic of Pittsburgh, including rail shipments east and rail and water shipments west, amounted to nearly 53,000,000 tons. The following statement showing the quantity of coal received in Pittsburgh and vicinity by rail and water, and the shipment of coal to and from the Pittsburgh district and to western points during the last five years, has been compiled from reports made to the Survey by the officials of railroads entering Pittsburgh and by the United States Army officer in charge of the slack-water navigation on Monongahela River and of the improvements at the Davis Island Dam in Ohio River below Pittsburgh. The railroad officials to whom special acknowledgment is due for the information contained in the tables are Messrs. R. H. Large, coal freight agent of the Pennsylvania Railroad at Philadelphia; James P. Orr, assistant freight traffic manager of the Pennsylvania lines west of Pittsburgh at Pittsburgh; W. L. Cromlish, coal and coke agent of the Baltimore & Ohio Railroad at Pittsburgh; J. B. Nessle, general freight agent of the Pittsburgh & Lake Erie Railroad at Pittsburgh; J. B. Safford, superintendent of the Pittsburgh, Chartiers & Youghiogheny Railway at Pittsburgh; and S. P. Woodside, general freight agent of the Wabash-Pittsburgh Terminal Railway at Pittsburgh. The statistics of the movement of coal through the Monongahela River locks and at the Davis Island Dam have been furnished by Lieut. Col. H. C. Newcomer, Engineer Corps, United States Army.

In the total movement of coal to Pittsburgh and points east and west thereof there was an increase in 1911 of 1,974,795 tons over 1910, all of the increase being in the shipments through or from the district. On account of the depression in the iron and steel trade the local consumption of coal at Pittsburgh decreased about 1,250,000 tons, or from 15,600,654 tons in 1910 to 14,349,644 tons in 1911. The rail shipments to Pittsburgh decreased about 1,000,000 tons and the water shipments about 250,000 tons. The decrease in the consumption of coke was, of course, much larger. The movements of coal both east and west, however, showed increases, shipments west increasing from 24,453,581 tons to 25,291,264 tons, all in water shipments to lower Mississippi River points, and eastern shipments, all rail, from 10,781,544 tons to 13,169,866 tons. The water shipments were the largest since 1907.

The rail and water shipments to and from the Pittsburgh district during the last five years are shown in the following table:

Movement of coal to and through Pittsburgh, 1907–1911, in short tons, showing totals by rail and water.

Destination.	1907	1908	1909	1910	1911
By rail:					
To Pittsburgh district	4,774,977	3,494,905	4,654,249	6,139,959	5,142,412
To west of Pittsburgh	20,817,263	18,970,848	18,981,995	[a]22,683,276	[a]22,474,289
Total by rail	25,592,240	22,465,753	23,636,244	28,823,235	27,616,701
By Monongahela River locks:					
To Pittsburgh district	7,611,680	6,435,851	9,737,505	9.460,695	9,207.232
To west of Pittsburgh	3,204,129	1,742,339	2,463,385	1,770,305	2,816,975
Total by water	10,815,809	8,178,190	12,200,890	11,231,000	12,024.207
Total shipments	36,408,049	30,643,943	35,837,134	40,054,235	39,640,908

[a] Includes a small quantity of coal sent to Lake Erie points.

Movement of coal to and through Pittsburgh, 1907–1911, in short tons, showing totals to Pittsburgh district and west of Pittsburgh.

Destination.	1907	1908	1909	1910	1911
To Pittsburgh district:					
By rail	4,774,977	3,494,905	4,654,249	6,139,959	5,142,412
By water	7,611,680	6,435,851	9,737,505	9,460,695	9,207,232
Total to Pittsburgh district	12,386,657	9,930,756	14,391,754	15,600,654	14,349,644
To west of Pittsburgh:					
By rail	20,817,263	18,970,848	18,981,995	22,683,276	22,474,289
By water	3,204,129	1,742,339	2,463,385	1,770,305	2,816,975
Total to west of Pittsburgh	24,021,392	20,713,187	21,445,380	24,453,581	25,291,264
Total shipments to Pittsburgh and points west	36,408,049	30,643,943	35,837,134	40,054,235	39,640,908
Shipments, all rail, to points east of Pittsburgh	12,202,530	11,666,160	11,300,162	10,781,544	13,169,866

BUFFALO, N. Y.

By John W. Chamberlain, trade press correspondent.

All the changes in the condition of the anthracite and bituminous coal trade during the year 1911, at Buffalo, N. Y., have been in the direction of a healthy increase, so far as tonnage is concerned, though the conditions of the traffic, from a standpoint of profit, have not taken the same direction. For this reason it may be a question as to the actual healthiness of the bituminous trade especially since the corresponding period in 1910. The former overproduction of bituminous coal continues.

Buffalo continues to be the chief northern distributing point for a great part of the Pennsylvania coals, the trend of bituminous coal being eastward as well, while anthracite more generally turns westward, on account of the position of the mines and the cheapness of rates by Lake. In late years the size of the Lake fleet has made it possible for coal shippers to make their own rates by that route, and they have reduced certain Lake Michigan rates the present season, on the assurance, no doubt, that since a cargo may now run above 10,000 tons, whereas it used to be a matter of 3,000 tons it is proper to cut down the rate per ton. The plan now is to pay a uniform rate of 30 cents to leading ports on both Lake Michigan and Lake Superior, giving certain ports a margin of 5 cents or more on account of some special difficulties attending navigation there.

The competing car-ferry route across Lakes Erie and Ontario promise to increase. There are two reasons for this. One is the increasing congestion of coal at the Niagara River bridges and the other s the dissatisfaction of a certain railway with existing ferry lines, some of which are said to have charged an increased rate on coal not in their direct interest. It is said to be settled that a fourth coal-car ferry ine to to be established, probably from Erie, Pa., to Canada, which will tend to reduce the coal passing through Buffalo, though possibly not to an extent greater than the natural increase of movement.

This diversion affects bituminous coal almost entirely, Buffalo maintaining her lead in the handling of anthracite. The following is the quantity of anthracite, in long tons, shipped by Lake, in round numbers: Buffalo, to upper Lakes, 3,666,000 tons; Erie, to upper Lakes, 425,000 tons; Oswego, to upper Lakes, 210,000 tons; Oswego, to Lake Ontario and St. Lawrence River, 470,000 tons; North Fair Haven, chiefly to Lake Ontario and St. Lawrence River, 100,000 tons; Sodus Point to Lake Ontario and St. Lawrence River, 6,000 tons, a total of 4,877,000 tons, which gives Buffalo a trifle more than three-fourths of the anthracite tonnage on the Great Lakes.

As to receipts by rail the figures available are only fragmentary. It does not appear that any totals are made up in anthracite and the only bituminous figures made public are as follows: To western New York, including Buffalo, Rochester, and intervening territory, but not including the tonnage of the cross-Lake car ferries, 7,655,000 long tons; to Buffalo proper and including the four car ferries, 7,244,000 tons, which still leaves the actual Buffalo receipts problematical. If another car ferry is built to connect the mines with Canada, this will somewhat draw away from the Buffalo movement. The Grand Trunk Railway last year bought coal territory in the No. 8 Ohio bituminous district and will, according to present plans, ship a good part of its output over this new route.

There is no very great change in the movement of coal to and through Buffalo from year to year. There is a moderate increase of water shipments of anthracite every year, the demand from Lake Superior ports increasing faster than the demand from Lake Michigan and other nearer ports falls off. The total consumption increases, but rail competition cuts down the quantities shipped by water to those ports that are more easily reached by rail.

There is a steady increase of competing fuels, which seriously displace both anthracite and bituminous, so that it is estimated that not more than 400,000 tons of anthracite is consumed in Buffalo annually. Discoveries of natural gas in apparently increased quantities within easy piping distances of the city continue, and if the present agitation is kept up the Niagara electric rates will be reduced, so that the slow increase of electric light and power will become rapid. There is a large increase of manufacturing in the city, which is perhaps sufficient to meet the distractions from fuels competing with bituminous coal.

That there is a steady increase of all coals shipped through Buffalo to Canada is shown by th customhouse figures, which are kept exact and may be safely used as a basis of calculation. The quantities exported for the last five years are as follows:

Exports of coal and coke from Buffalo to Canada, 1907–1911, in long tons.

Year.	Anthracite.	Bituminous.	Coke	Total.
1907	809,192	2,036,914	204,821	3,050,947
1908	786,063	1,726,332	213,712	2,726,107
1909	800,741	1,748,759	350,085	2,800,585
1910	931,378	2,014,762	420,805	3,366,945
1911	1,695,035	2,620,727	416,069	4,231,831

Bituminous mining in the Allegheny Valley is increasing steadily, especially in the larger operations. The liberal holdings of these operations in Buffalo are without material change.

CINCINNATI, OHIO.

[From the annual report of W. C. Culkins, superintendent and executive secretary of the Cincinnati Chamber of Commerce.]

Increase in volume and decrease in prices were the features of the coal trade of Cincinnati in 1911. Predictions that natural gas would reduce the consumption do not appear to have been verified despite the largely extended use of the commodity. Receipts both by river and rail were far head of preceding years. On the whole receipts were more than 2,000,000 tons ahead of those for 1910, and according to chamber of commerce reports on the subject 1911 broke all records.

Reports of the chamber of commerce also indicate an increase in coal received from other than the Kanawha district, pointing to the enlargement of Cincinnati as a consuming and distributing center for bituminous coal coming to it from all points of the compass.

Lower prices of coal in Cincinnati appear to have resulted from a combination of circumstances. Early in the year Kanawha and Pittsburgh lump delivered was quoted at $3.75 per ton; nut and slack at $2; lump in cars at $2.80; nut and slack at $1.70; as compared with $3.25 lump delivered early in 1910. However, there was no market, an unexplainable dullness having set in. This brought prices of lump coal down to $3.50 per ton in February, and in April to $3.25, which failed to stimulate the trade materially. From April to September followed a period of extremely low water, indicating a scarcity of coal in the fall, but with September came the unexpected rise and a high stage continued to the end of the year. This was supplemented by unseasonable weather, and though business improved in October and November in anticipation of cold weather, its failure to arrive caused a falling off. This held prices steady at $3.25 per ton against $3.75 a year previous. Lump coal on cars dropped to $2.45 per ton in March and to $2.40 in April, where it remained.

Smokeless opened the year at $4.25 per ton, dropped to $3.75 in April, and to $3.50 in the early summer, reacted to $4 in July, and advanced to $4.25 in December. Anthracite receipts were much smaller, showing that the use of gas affected the hard coal particularly.

The annual receipts of coal, in bushels, at Cincinnati, according to reports of gagers, private returns, and records of the chamber of commerce, for the last five years have been as follows:

Receipts of coal at Cincinnati, 1907–1911, in bushels.

Year.	By river.			By rail.		
	Pittsburgh.	Kanawha.	Other kinds.	Kanawha.	Other kinds.	Anthracite.
1907	30,726,000	33,495,000	426,000	46,573,000	38,106,000	654,000
1908	13,397,000	21,689,000	679,000	46,209,000	37,808,000	855,000
1909	20,765,000	25,252,000	39,000	49,005,000	40,095,000	471,000
1910	12,678,000	23,765,000	176,000	68,780,000	56,275,000	337,000
1911	18,368,186	38,289,304	....	77,353,360	62,684,692	147,000

The total annual receipts, by river and by rail, and aggregate receipts, with total annual shipments, by river and by rail, and aggregate shipments for the last five years are given in the following table:

Movements of coal at Cincinnati, 1907–1911, in bushels.

Year.	Receipts.			Shipments.		
	By river.	By rail.	Aggregate.	By river.	By rail.	Aggregate.
1907	64,647,000	85,333,000	149,980,000	5,006,000	66,408,000	71,414,000
1908	35,765,000	84,872,000	120,637,000	3,380,000	60,854,000	64,234,000
1909	46,056,000	89,571,000	135,627,000	6,727,000	63,211,000	69,938,000
1910	36,619,000	125,392,000	162,011,000	4,256,000	100,920,000	105,176,000
1911	56,657,490	140,038,052	196,695,542	6,151,915	101,933,540	108,085,445

The total annual receipts of coal at Cincinnati, in tons of 2,000 pounds, for the last 10 years, have been as follows:

Annual receipts of coal at Cincinnati, 1902–1911, in short tons.

1902	3,766,796	1907	5,402,000
1903	4,046,710	1908	4,346,000
1904	4,257,613	1909	4,896,000
1905	5,791,000	1910	5,849,000
1906	6,265,000	1911	7,479,000

CLEVELAND, OHIO.

The total coal and coke receipts at Cleveland, as reported by Mr. Munson A. Havens, secretary of the Cleveland Chamber of Commerce, amounted in 1911 to 7,322,595 short tons, compared with 8,435,309 tons in 1910, indicating a decrease in 1911 of 1,112,714 tons. The decrease in quantity was chiefly in the receipts of bituminous coal, which fell off from 7,097,170 tons in 1910 to 6,242,910 tons in 1911, but proportionately the decrease in anthracite shipments was greater, the receipts in 1911 (168,208 tons) being about one-third those of 1910 (400,425 tons). There was, however, a marked increase in the local consumption of bituminous coal in 1911, as the quantity forwarded to other points was nearly 2,300,000 tons less than in 1910. The difference between receipts and shipments in 1910 was 1,600,394 tons; in 1911, it was 3,134,169 tons, indicating an increase of about 1,500,000 tons in local consumption, stocks on hand being eliminated. Coke receipts decreased slightly and shipments increased, the difference in the local consumption being about 100,000 tons.

The following tables show the quantities of anthracite and of bituminous coal and coke received at and shipped from Cleveland during the last six years:

Coal and coke receipts and shipments at Cleveland, Ohio, 1906–1911, in short tons.

RECEIPTS.

Kind.	1906	1907	1908	1909	1910	1911
Bituminous	6,021,958	5,995,197	5,715,781	6,264,998	7,097,170	6,242,910
Anthracite	145,822	153,077	515,717	363,162	400,425	168,208
Coke	659,307	849,850	690,742	1,034,649	937,714	911,477
Total	6,827,087	6,998,124	6,922,240	7,662,809	8,435,309	7,322,595
SHIPMENTS.						
Anthracite by rail	10,138	7,553	41,428	25,383	18,020	....
Bituminous by rail	45,687	112,500	82,542	122,814	383,408	....
Bituminous by lake	2,926,279	3,264,875	3,350,830	4,602,275	5,023,368	3,108,741
Coke by rail	117,718	56,738	75,559	102,375	197,784	273,313
Total	3,099,822	3,441,666	3,550,359	4,852,847	5,622,580	3,382,054

Total coal receipts and shipments, with local consumption, at Cleveland, Ohio, 1906–1911, in short tons.

Year.	Receipts.	Shipments.	Local consumption.
1906	8,827,087	3,099,822	3,727,265
1907	6,998,124	3,441,666	3,556,458
1908	6,922,240	3,550,359	3,371,881
1909	7,662,809	4,852,847	2,809,962
1910	8,435,309	5,622,508	2,812,801
1911	7,322,595	3,382,054	3,940,541

MILWAUKEE, WIS.

[From the annual report of H. A. Plumb, secretary of the Milwaukee Chamber of Commerce.]

The receipts by car-ferry lines across Lake Michigan from Ludington and Grand Haven, by the Pere Marquette and the Grand Trunk railways, respectively, amounted in 1911 to 265,572 short tons, compared with 327,415 tons in 1910. The all-rail lines, the Chicago, Milwaukee & St. Paul, the Chicago & North Western, and the Soo Line, brought in 143,917 tons in 1911, an increase from 122,454 tons in 1910.

With the car-ferry or cross-Lake receipts included, the total quantity of coal shipped into Milwaukee by way of the harbor was 4,870,994 tons. The total receipts by both Lake and rail were 5,014,911 tons—with a single exception of 1910, the largest quantity recorded during any one year.

The largest cargo of the year was that of the *Geo. G. Crawford*, early in the season, and consisted of 11,975 tons of hard coal from Buffalo. The average size of the 779 cargoes received during the year was 5,912 short tons. Of these 779 cargoes, 54 contained 10,000 tons or over, and 5 consisted of 11,000 tons or over. The largest previous cargo of coal received at Milwaukee was that of the *L. S. De Graff*, in 1909, with 12,885 tons.

Almost 32 per cent of the entire receipts of the year was shipped from Toledo, 1,453,631 tons, the largest quantity ever recorded as coming from a single point to the Milwaukee market.

Stocks of certain grades of anthracite were practically exhausted by the close of the winter of 1911–12, and the opening of navigation was awaited with some anxiety.

Prices were not readjusted to the usual scale on April 1 of the present year (1912) on account of labor troubles in the mining region, and the situation with reference to the coal trade holds many elements of uncertainty.

The receipts of coal at and the shipments from Milwaukee during the last five years and the total receipts for a series of years since 1865 are shown in the following tables.

Receipts of coal at Milwaukee, Wis., 1907–1911, in short tons.

Source.	1907	1908	1909	1910	1911
By Lake from—					
Buffalo	813,904	1,005,594	778,392	810,409	909,080
Erie	140,313	17,359	80,980	82,072	90,342
Oswego	28,428	58,285	56,588	68,983	65,166
Cleveland	740,785	520,244	382,828	436,057	219,852
Ashtabula	318,046	167,851	212,314	520,376	446,330
Lorain	204,873	337,465	610,444	671,656	848,687
Sandusky	457,582	451,807	393,869	388,467	369,601
Toledo	1,064,666	891,626	1,057,076	1,311,786	1,453,631
Fairport	50,041	77,001	108,210	61,737	107,803
Huron, Ohio	134,508	22,425	26,015	86,046	64,780
Other ports	88,366	111,510	115,358	173,743	30,150
Total Lake	4,039,512	3,661,167	3,822,074	4,611,332	4,605,422
By railroad	[a] 309,995	[b] 380,759	[c] 353,948	[d] 449,869	[e] 409,489
Total receipts	4,349,507	4,041,926	4,176,022	5,061,201	5,014,911

[a] Including 132,516 tons by car ferry.

[b] Including 168,205 tons by car ferry.

[c] Including 205,669 tons by car ferry.

[d] Including 327,415 tons by car ferry.

[e] Including 265,572 tons by car ferry.

Shipments of coal from Milwaukee, Wis., 1907–1911, in short tons.

Shipped by—	1907	1908	1909	1910	1911
Chicago, Milwaukee & St. Paul Ry	698,040	632,184	776,010	1,019,330	765,980
Chicago & North Western Ry	509,271	471,101	483,250	530,010	543,840
Wisconsin Central Ry.[a]	103,551	99,411	123,500	139,435	119,135
Lake				360	60
Total	1,310,862	1,202,696	1,382,760	1,689,135	1,429,015

[a] The Wisconsin Central Railway has now become the "Soo line."

Receipts of coal by Lake at Milwaukee, Wis., 1907–1911, by kinds, in short tons.

Kind.	1907	1908	1909	1910	1911
Anthracite	858,402	1,063,879	834,980	930,472	1,013,907
Bituminous	3,181,110	2,597,288	2,987,094	3,680,860	3,591,515
Total	4,039,512	3,661,167	3,822,074	4,611,332	4,605,422

Receipts of coal at Milwaukee, Wis., by Lake and rail, in 1865, 1870, 1880, 1890, and annually from 1900 to 1911, in short tons.

1865	36, 369	1904	2, 944, 439
1870	122, 865	1905	3, 157, 464
1880	368, 568	1906	3, 815, 275
1890	999, 657	1907	4, 349, 507
1900	1, 808, 593	1908	4, 041, 926
1901	1, 953, 489	1909	4, 176, 022
1902	1, 641, 095	1910	5, 061, 201
1903	3, 023, 977	1911	5, 014, 911

Lake freights on coal from Buffalo to principal upper Lake ports during the season of 1911, as compared with those of 1910, were as follows:

Freight rates per ton on coal from Buffalo to principal upper Lake ports, 1910 and 1911, by months.

Month.	To Milwaukee.		To Chicago.				To Duluth.	
			North Branch.		South branch.			
	1911	1910	1911	1910	1911	1910	1911	1910
March	$0.35	$0.35	$0.40	$0.40	$0.45	$0.45	$0.30	$0.30
April	.35	.35	.40	.40	.45	.45	.30	.30
May	.35	.35	.40	.40	.45	.45	.30	.30
June	.35	.35	.40	.40	.45	.45	.30	.30
July	.35	.35	.40	.40	.40	.40	.30	.30
August	.35	.35	.40	.40	.40	.40	.30	.30
September	.35	.35	.40	.40	.40	.40	.30	.30
October	.35	.35	.40	.40	.40	.40	.30	.30
November	.35	.35	.40	.40	.40	.40	.30	.30
December	1.00	.50	1.00	.50	1.00	.30	1.00	.50

ST. LOUIS, MO.

According to Mr. Wm. F. Saunders, secretary and general manager of the Business Men's League of St. Louis, less bituminous coal was burned in St. Louis during 1911, because there was a large increase in the consumption of anthracite coal and of coke. This is explained by Mr. J. S. Kuhn, the coal expert of St. Louis, who prepared the figures for the Business Men's League, by the activity of the smoke-abatement movement on the part of the leading manufacturers of the city, which has caused a larger demand for the smokeless fuels, such as anthracite coal, coke, and the smokeless bituminous coal of West Virginia.

Before this smoke-abatement movement assumed activity these smokeless fuels were used principally and almost entirely for the heating of dwellings, but many of the apartment houses and small manufacturing plants have begun to use the smokeless fuels, and the demand for them will no doubt continue.

There were no strikes nor serious labor troubles in the Illinois producing coal fields during the year, and consequently no interruptions to the supply of coal from that source.

The receipts of coal and coke at St. Louis for the last six years and the high, low, and closing prices in 1910 and 1911 are shown in the following tables:

Coal and coke receipts at St. Louis, Mo., 1905–1911, in short tons.

Year.	Bituminous.	Anthracite.	Coke.	Year.	Bituminous.	Anthracite.	Coke.
1905	6,869,107	158,843	494,011	1909	7,418,268	236,040	171.570
1906	7,621,613	174,226	729,778	1910	7,945,680	289,463	191,190
1907	8,477,476	265,571	826,400	1911	7,798,309	487,030	192,425
1908	7,129,055	236,036	357,016				

Coal prices at St. Louis, Mo., during 1910 and 1911, in short tons.

Kind.	1910			1911		
	Highest.	Lowest.	Closing.	Highest.	Lowest.	Closing.
Standard Illinois lump coal	$2.52	$1.37	$1.62	$1.77	$1.27	$1.62
High-grade Illinois lump coal	2.92	1.97	1.97	2.42	1.67	1.92
Anthracite, large	6.70	6.20	6.70	6.70	6.20	6.70
Anthracite, small	6.95	6.45	6.95	6.95	6.45	6.95
Connellsville coke	5.40	5.05	5.40	6.15	5.00	6.10
New River coke	5.40	5.05	5.40	5.70	4.85	5.65
Kentucky coke	4.10	3.50	4.10	3.95	3.65	3.95
Gas coke	4.65	4.15	4.40	4.90	4.40	4.90

SAN FRANCISCO, CAL.

In the opinion of Mr. James B. Smith, vice president of the Western Fuel Co., to whom the writer is indebted for the following notes, the coal mines of British Columbia will in the future furnish the greater part of the coal consumed in San Francisco, and increasing quantities will be received from there, while shipments from Australia and other foreign countries will decline. In 1911 the shipments from Australia amounted to approximately 200,000 tons. It is believed that the receipts of Australian coal will not exceed 100,000 tons in 1912, and unless conditions change considerably during the next few years coal from that source will be little used. Much development work in the British Columbian fields is now in progress, and the mines will soon be able to meet the requirements of the Pacific coast without importations from other countries. It must be remembered that the consumption of oil is increasing rapidly, and until the production has reached its maximum or is no longer able to supply the demand there is little prospect for any increase in the consumption of coal except for domestic purposes.

Competent oil men are of the opinion that if the demand warranted production could be increased from 83,000,000 barrels, as it was in 1911, to 120,000,000 or 130,000,000 barrels in three or four years, so that if the normal development of the coast should require from 10 to 15 per cent increase annually it would not absorb the possible maximum production. What may be required 15 or 20 years hence it is of course impossible to say, but the probability is that in the course of eight or nine years the consumption of oil will equal the productive capacity.

In addition to the fuel-oil supply the development of water power has gone ahead to such an extent that any abnormal demand could be easily met by the water-power reserves. In the event of a sudden expansion that might create a demand for power there is, of course, the development of the Alaskan coal fields. According to the present outlook there will be no necessity for a change in the governmental policy of conserving these coal lands during the next 15 or 20 years. At the present rate of coal consumption on the Pacific coast the sources of supply can more than take care of the demands, and Alaska is handicapped by climatic conditions and distance in transportation, compared with Washington and British Columbia.

Mr. Smith has had compiled for this report the following statement of the coal and coke receipts by water at San Francisco during the last five years and the sources from which they were obtained. It shows that the water arrivals increased from 486,385 long tons (544,751 short tons) in 1910 to 560,096 long tons (627,308 short tons) in 1911. The features of the trade in 1911 were increased receipts from British Columbia and Australia and marked decreases from Japan and Oregon. Receipts of coal from Eastern States also fell off about 20,000 tons, or about 20 per cent. In addition to the 627,308 short tons of coal received by water 25,243 tons were brought by rail from New Mexico, Utah, and Wyoming mines,[1] and 93,816 long tons (105,074 short tons) of coke were imported by water from foreign countries, chiefly Great Britain.

Sources of coal consumed in California, 1907–1911, in long tons.

(Includes arrivals by water only at port of San Francisco.)

Source.	1907	1908	1909	1910	1911
British Columbia	243,677	165,204	188,125	157,489	207,203
Australia	142,924	452,819	68,086	115,179	198,730
Great Britain	31,359	21,805	3,105	....	2,639
China	....	....	....	....	6,170
Japan	33,598	58,170	546	38,817	279
Oregon	32,645	22,205	24,125	23,293	7,439
Washington	85,738	69,947	16,940	50,342	57,298
Eastern	34,333	188,110	69,696	101,265	80,338
Total	604,274	978,260	370,623	486,385	560,096

The coke consumed at San Francisco annually is estimated to amount to 30,000 short tons. This is exclusive of the consumption by the smelter at Kennett, and by the Selby Smelting & Refining Co. on San Francisco Bay. The total receipts of coke at San Francisco during 1911 were 93,816 long tons, or 105,074 short tons. The price of coke at San Francisco ranges from $7.50 to $14 per long ton, ship. The following table gives the receipts of coke at San Francisco during the last five years and the sources from which they were obtained:

Imports of coke at San Francisco, Cal., 1907–1911, in long tons.

Source.	1907	1908	1909	1910	1911
Great Britain	46,988	47,782	59,804	57,496	87,296
Australia	5,432	18,630	14,955	14,442	3,725
Washington	....	303	....	....	....
Japan	....	....	....	2,500	2,795
Total	52,420	66,715	74,759	74,438	93,816

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[1] For statements of railroad shipments to San Francisco and other points in California, the Survey is indebted to Mr. H. M. Adams, freight traffic manager, Western Pacific Railway; Mr. Edward Chambers, freight traffic manager, Atchison, Topeka & Santa Fe Railway; and Mr. H. A. Jones, freight traffic manager, Southern Pacific Co.

The Bureau of Statistics of the Department of Commerce and Labor reports that in the fiscal year ended June 30, 1911, the imports of foreign coal into San Francisco amounted to 407,920 long tons, of which 5,908 tons were anthracite and 402,012 tons were bituminous.

It is estimated that the total consumption of California oil for fuel purposes in 1911 was 52,000,000 barrels, of which 27,000,000 barrels are considered as the consumption by manufacturing concerns, including gas companies, 21,000,000 barrels by railroads, and 4,000,000 barrels by steamers. Of the last item it is estimated that 3,700,000 barrels were used in the coastwise trade, and 300,000 barrels by trans-Pacific steamers. The prices for California oil at various points during 1911 are given below, the prices being at delivery stations:

Prices of California crude petroleum in 1911 at various places.

	Cents per barrel.
Oleum, Cal., 14° gravity oil	70
Oleum, Cal., 23° gravity oil	80
Oleum, Cal., asphaltic road oil, 80 per cent	80
Oleum, Cal., asphaltic road oil, 90 per cent	90
San Francisco, Cal., 14° gravity oil	70
Oakland, Cal., 14° gravity oil	75
Stockton, Cal., 14° gravity oil	80
Sacramento, Cal., 14° gravity oil	80
Seattle, Wash., 14° gravity oil	85
Portsmouth, Oreg., 14° gravity oil	85
Astoria, Oreg., 14° gravity oil	85
San Pedro, Cal., 14° gravity oil	70
San Diego, Cal., 14° gravity oil	75
Port San Luis, Cal., 14° gravity oil	70

It is to be noted that 14° gravity oil at San Francisco is 70 cents per barrel, and at Seattle it is 85 cents, a difference of only 15 cents per barrel. Exclusive of any economy in labor, the competition of the California oil at Puget Sound is represented by the fact that Washington coal would have to be delivered in bunkers at \$3.17½ per ton to meet the equivalent value of California oil. The consumption of 52,000,000 barrels of oil for fuel purposes is equivalent to nearly 15,000,000 tons of coal. The entire consumption of coal on the Pacific coast of the United States in 1911 was less than 4,000,000 tons.

The following is a list of steamers inspected at San Francisco during 1911, showing those for which permits to burn petroleum have been issued:

Steamers inspected at San Francisco in 1911.

	Total.		Oil burners.	
	Number.	Tonnage.	Number.	Tonnage.
Ocean passenger steamers	78	181,167	40	43,261
Inland passenger steamers	42	18,267	36	17,811
Ferry steamers	28	38,021	24	34,128
Ocean freight steamers	120	210,406	77	87,531
Inland freight steamers	32	12,780	28	11,475
Ocean towing steamers	12	2,126	7	1,599
Inland towing steamers	29	2,386	21	1,858
Ocean pleasure yachts	2	188	1	129
Miscellaneous	22	3,680	10	1,237

SEATTLE AND TACOMA, WASH.

The coal requirements of Seattle and Tacoma are supplied from the mines in King and Pierce counties, the average railroad haul from the mines to either port being less than 100 miles and for a considerable portion of the tonnage not over 50 miles. The combined production of King and Pierce counties in 1911 was 2,042,717 short tons, which would represent approximately the total consumption at the two cities and the smaller towns in the vicinity. The consumption of coal has not kept pace with the development of that section of the country, as California oil has to a large extent supplanted coal even at Puget Sound ports, which are almost at the mouths of the coal mines. The use of oil has practically taken the place of coal for railroad consumption, this change being due to the necessity for a sparkless fuel in that heavily forested region. The Great Northern Railway is using fuel oil on its mountain divisions; the Chicago, Milwaukee & Puget Sound Railway is doing the same across the State of Washington; and the Northern Pacific, which has its own coal mines at Roslyn, about 100 miles from the Sound, is adopting liquid fuel. In California the Southern Pacific is using oil as far east as Sparks, Nev. To the north, in British Columbia, the Canadian Pacific is also changing from coal to oil. The manager of transportation of the Seattle Chamber of Commerce, Mr. W. A. Mears, states that from 75 to 85 per cent of the steamers plying on Puget Sound, 80 to 90 per cent of the steamers engaged in coastwise service, 30 per cent of those crossing the Pacific, and 80 per cent of the locomotives running out of Seattle are using oil, and that this fuel makes up from 50 to 80 per cent of the local consumption for manufacturing and domestic purposes. A considerable portion of the fuel used for domestic purposes at Seattle and Tacoma is wood. The port warden's report for 1911 shows that out of a total of 30 steamers engaged in the coastwise trade and having an aggregate capacity of 32,609 tons, 11 steamers, with a total of 10,142 tons, were oil burners, and out of 44 steamers (total tonnage 20,510) on Puget Sound, 35, with a total of 15,920 tons, burned oil. Most of the steamers, other than those engaged in coastwise and Sound service, which come to Seattle and Tacoma touch also at Vancouver and Victoria, British Columbia, and take on their bunker supplies at one of the latter places. The following table shows the tendency of coal loaded into vessels at Seattle and Tacoma during the last three years:

Coal shipped at Seattle and Tacoma, 1909–1911.

	1909	1910	1911
	Short tons.	*Short tons.*	*Short tons.*
Bunker (fuel) coal at Seattle	296,869	286,825	249,710
Bunker coal at Tacoma	25	9,235	15,356
Cargoes to San Francisco	21,676	66,438	47,066
Total	318,570	362,498	312,132

According to the Bureau of Statistics, Department of Commerce and Labor, 33,346 short tons of bunker coal were loaded into foreign ships, and 15,859 tons were exported.

Prices for coal at Seattle and Tacoma during 1911 ranged about as follows:

Prices of coal at Seattle and Tacoma in 1911.

To large consumers.		Per long ton.	Freight.
From King County mines:			
Black Diamond	mine run	$2.00	$0.50
Gem	do	2.00	.60
Nolte	steam	2.25	[a].65
Renton screenings	do	1.00	.40
Newcastle screenings	washed pea	1.25	.40
From Pierce County mines:			
Carbonado	slack	1.17	[a].65
Douty	steam	2.50	[a].65
Wingate	do	3.00	[a].65
Wilkeson	do	2.25	[a].65
Pittsburg	do	2.20	[a].65
South Prairie	do	2.90	[a].65
Gale Creek	do	2.80	[a].65

[a] To Seattle; rate to Tacoma is 5 cents a ton less. An additional charge of 15 cents is made for bunkering.

For local delivery in Seattle coal for domestic use is sold by the short ton; Pennsylvania anthracite domestic sizes, egg, stove, and nut, bring $16.50 per short ton. Prices for other domestic coals in 1911 were as follows:

Prices for domestic coal in Seattle, Wash., in 1911.

		Per short ton.
From Pierce County mines:		
Carbonado-Douty	furnace	$4.25 to $5.50
Carbonado-Douty	lump	4.75 to 6.00
Wingate	do	6.75 to 7.00
Wingate	furnace	5.00 to 6.25
Wellington	lump	7.25 to 8.50
Lady Wellington	do	4.75 to 6.00
From King County mines:		
Newcastle	lump	5.00 to 6.25
Newcastle	nut	3.25 to 4.50
Black Diamond	lump	6.75 to 8.00
Renton lignite	do	5.00 to 6.25
Renton lignite	nut	3.50 to 4.75
Centralia lignite	lump	4.50 to 5.75

Lump coal goes over a 3-inch bar screen; steam through 3-inch screen and over screens ranging from one-fourth to seven-eighths inch.

The chief requirement in fuel at Seattle and Tacoma, as at other cities of the Pacific coast, is good furnace and foundry coke at reasonable prices. It is estimated that the pig iron consumption by foundries on Puget Sound is about 25,000 tons a year, principally from Scotland in ballast, and that 1 ton of coke is required for 5 tons of pig. The Tacoma smelter is the principal consumer of coke on Puget Sound. It uses about 2,500 tons of coke a month when running full time. This coke comes from the Wilkeson ovens in Pierce County. Foundry coke is imported.

PORTLAND, OREG.

Portland is not a large consumer of coal. For domestic purposes the principal fuel is wood or gas, and the climate even in winter is not so rigorous that furnaces in dwellings are necessary. The bunker trade in coal is small and irregular, not exceeding 5,000 long tons annually. All of the bunker coal handled is from Washington mines, except for small lots occasionally left in Australian steamers and discharged at Portland. The following statement of the number and tonnage of ocean and river steamers and the fuel used by them has been obtained from the office of the United States inspector of hulls and boilers:

Steamers inspected at Portland, Oreg., in 1911.

	Oil burners.		Coal burners.	
	Number.	Tonnage.	Number.	Tonnage.
Ocean vessels	7	1,904	3	1,266
River steamers	56	16,236	8	2,704

There were also 24 wood-burning river steamers with a total of 3,744 tons register inspected in 1911. The coke consumption at Portland, as at other cities of the Pacific coast, is for foundry purposes. That used at Portland comes chiefly from England and Germany and is known as "Pelton-Main" and "German Syndicate." Some retort-oven coke is brought from the Eastern States, and a smal quantity of beehive coke is received from British Columbia and Washington. The price of English coke at Portland is approximately $10 per long ton on the wharf. Wilkeson (Washington) coke, which runs from 15 to 20 per cent ash, sells at from $8 to $9 per ton. Connellsville and retort-oven coke by rail usually sells from $16 to $17 per ton, although in February, 1912, $13.50 was quoted for Connellsville coke delivered at Portland, the lowest price ever quoted.

LOS ANGELES, CAL.

The coal consumption of Los Angeles is relatively insignificant briquetted fuel made by the Los Angeles Gas & Electric Co. from petroleum residue probably exceeding coal as a domestic fuel. Oil is used exclusively for steam raising, and gas made from oil is th principal kitchen fuel. Coke for foundry purposes is used to th extent of from 37,500 to 50,000 tons a year. Some of this is "German Syndicate" and some "Pelton-Main," but most of it is from Connellsville. The price of the coke is from $13 to $13.50 per ton

PRODUCTION OF COAL BY STATES.

GEOGRAPHIC DIVISIONS.

Thirty-one States, including Alaska, produced coal in the Unite States in 1911, or two more than in 1910. Of these 31 States, 13 ar east of Mississippi River and 18 west of that dividing stream. Th 13 States east of Mississippi River produced in 1911 442,043,55 short tons, or 89.1 per cent of the total, whereas the 18 States wes of the river produced 54,177,617 short tons, or 10.9 per cent. Th was practically no change in the percentage of the total for both the Eastern and the Western States, as in 1910 the States east of the Mississippi produced 446,471,005 short tons, or 89 per cent of the total, and the Western States produced 55,125,373 short tons, or 11 per cent. In 1909 the percentages were, respectively, 88.1 and 11.9. Owing to the natural geographic position of the States east of Mississippi River, made by the boundary line formed by Ohio and Potomac rivers, six of the coal-producing States east of the Mississippi lie north of the Ohio and the Potomac and seven are to the south. The six Northern States are Pennsylvania, Maryland, Ohio, Illinois, Indiana, and Michigan. These States in 1911 produced 340,020,558 short tons, or 68.5 per cent of the total; in 1910 they produced 340,258,583 short tons, or 67.8 per cent of the total. The seven Southern States are Virginia, West Virginia, Alabama, Georgia, Tennessee, Kentucky, and North Carolina. These States in 1911 produced 102,022,993 short tons, or 20.6 per cent of the total; in 1910 these States (exclusive of North Carolina, which produced no coal in that year) had an output of 106,212,422 short tons, or 21.2 per cent of the total. The relative progress made by the Southern States in the 31 years from 1880 to 1911 exhibits a remarkable growth. In 1880 the Northern States produced 63,044,558 short tons of coal, and the production in 1911 was about 5.4 times that of 1880; the Western States produced in 1911 about 12 times the 1880 output of 4,705,271 short tons; and the production of the Southern States in 1911 of 102,022,993 short tons was about 27 times the 3,793,308 tons produced in 1880.

The productions of the various States, grouped according to the geographic divisions made by the Mississippi, the Ohio, and the Potomac, in 1880, 1890, 1900, 1910, and 1911, are shown in the following table:

Coal production in States north of Ohio and Potomac rivers in 1880, 1890, 1900, 1910, and 1911, in short tons.

State.	1880		1890		1900	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Illinois	6,115,377	$8,779,832	15,292,420	$14,171,230	25,767,981	$26,927,185
Indiana	1,454,327	2,150,258	3,305,737	3,259,233	6,484,086	6,687,137
Maryland	2,228,917	2,585,537	3,357,813	2,899,572	4,024,688	3,927,381
Michigan	100,800	224,500	74,977	149,195	849,475	1,259,683
Ohio	6,008,595	7,719,667	11,494,506	10,783,171	18,988,150	19,292,246
Pennsylvania:						
Anthracite	28,711,379	42,282,948	46,468,641	66,383,772	57,367,915	85,757,851
Bituminous	18,425,163	18,567,129	42,302,173	35,376,916	79,842,326	77,438,545
Total	63,044,558	$82,309,871	122,296,267	133,023,089	193,324,621	221,290,028

State.	1910		1911	
	Quantity.	Value.	Quantity.	Value.
Illinois	45,900,246	$52,405,897	53,679,118	$59,519,478
Indiana	18,389,815	20,813,659	14,201,355	15,326,808
Maryland	5,217,125	5,835,058	4,685,795	5,197,066
Michigan	1,534,967	2,930,771	1,476,074	2,633,803
Ohio	34,209,668	35,932,288	30,759,986	31,810,123
Pennsylvania:				
Anthracite	84,485,236	160,275,302	90,464,067	175,189,392
Bituminous	150,521,526	153,029,510	144,754,163	146,347,858
Total	340,258,583	431,222,485	340,020,558	436,024,528

Coal production in States south of Ohio and Potomac rivers in 1880, 1890, 1900, 1910, and 1911, in short tons.

State.	1880		1890		1900	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Alabama	323,972	$476,911	4,090,409	$4,202,469	8,394,275	$9,793,785
Georgia	154,644	231,605	228,337	238,315	315,557	370,022
Kentucky	946,288	1,134,960	2,701,496	2,472,119	5,328,964	4,881,577
North Carolina	350	400	10,262	17,864	17,734	23,447
Tennessee	495,131	629,724	2,169,585	2,395,746	3,509,562	4,003,082
Virginia	43,079	99,802	784,011	589,925	2,393,754	2,123,222
West Virginia	1,829,844	2,013,671	7,394,654	6,208,128	22,647,207	18,416,871
Total	3,793,308	4,587,073	17,378,754	16,124,566	42,607,053	39,612,006

State.	1910		1911	
	Quantity.	Value.	Quantity.	Value.
Alabama	16,111,462	$20,236,853	15,021,421	$19,079,94
Georgia	177,245	259,122	*a* 165,330	246,44
Kentucky	14,623,319	14,405,887	13,706,839	13,617,21
Tennessee	7,121,380	7,925,350	6,433,156	7,209,73
Virginia	6,507,997	5,877,486	6,864,667	6,254,80
West Virginia	61,671,019	56,665,061	59,831,580	53,670,51
Total	106,212,422	105,369,759	102,022,993	100,078,66

a Includes North Carolina.

Coal production in States west of Mississippi River in 1880, 1890, 1900, 1910, and 1911 in short tons.

State.	1880		1890		1900	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Arkansas	14,778	$33,535	399,888	$514,595	1,447,945	$1,653,61
California	236,950	663,013	110,711	283,019	172,908	540,03
Colorado	462,747	1,041,350	3,094,003	4,344,196	5,244,364	5,858,03
Idaho	....	....	....	....	10	5
Indian Territory	120,947	274,550	869,229	1,579,188	1,922,298	2,788,12
Iowa	1,461,116	2,507,453	4,021,739	4,995,739	5,202,939	7,155,34
Kansas	771,442	1,517,444	2,259,922	2,947,517	4,467,870	5,454,69
Missouri	844,304	1,464,425	2,735,221	3,382,858	3,540,103	4,280,32
Montana	224	800	517,477	1,252,492	1,661,775	2,713,70
Nebraska	200	750	1,500	4,500	....	....
New Mexico	....	....	375,777	504,390	1,299,299	1,776,17
North Dakota	....	....	30,000	42,000	129,883	158,34
Oregon	43,205	97,810	61,514	177,875	58,864	220,0
Texas	....	....	184,440	465,900	968,373	1,581,91
Utah	14,748	33,645	318,159	552,390	1,147,027	1,447,7
Washington	145,015	389,046	1,263,689	3,426,590	2,474,093	4,700,0
Wyoming	589,595	1,080,451	1,870,366	3,183,669	4,014,602	5,457,9
Total	4,705,271	9,104,272	18,113,635	27,656,918	33,752,353	45,786,1

Coal production in States west of Mississippi River in 1880, 1890, 1900, 1910, and 1911, in short tons—Continued.

State.	1910		1911	
	Quantity.	Value.	Quantity.	Value.
Arkansas	1,905,958	$2,979,213	2,106,789	$3,396,849
California	[a] 12,164	33,336	[a] 11,647	23,297
Colorado	11,973,736	17,026,934	10,157,383	14,747,764
Idaho	4,448	17,426	[b] 1,821	4,872
Iowa	7,928,120	13,903,913	7,331,648	12,663,507
Kansas	4,921,451	7,914,709	6,254,228	9,645,572
Missouri	2,982,433	5,328,285	3,760,607	6,431,066
Montana	2,920,970	5,329,322	2,976,358	5,342,168
New Mexico	3,508,321	4,877,151	3,148,158	4,525,925
North Dakota	399,041	595,139	502,628	720,489
Oklahoma	2,646,226	5,867,947	3,074,242	6,291,494
Oregon	67,533	235,229	46,661	108,033
Texas	1,892,176	3,160,965	1,974,593	3,273,288
Utah	2,517,809	4,224,556	2,513,175	4,248,666
Washington	3,911,899	9,764,465	3,572,815	8,174,170
Wyoming	7,533,088	11,706,187	6,744,864	10,508,863
Total	55,125,373	92,964,777	54,177,617	90,106,023

[a] Includes Alaska.

[b] Includes Nevada.

INDIVIDUAL STATES.

The production of coal in the several States in 1911 and preceding years is discussed more in detail in the following pages.

ALABAMA.

Total production in 1911, 15,021,421 short tons; spot value, $19,079,949.

From the depressed condition of the iron industry in 1911, it was estimated, in a preliminary review published in the closing week of the year, that the coal production of Alabama had decreased about 10 per cent from the high record of 16,111,462 short tons made in 1910. The quantity of coal made into coke, which is immediately affected by the demands of the iron furnaces, did show the marked decrease of 1,288,111 short tons, or 29 per cent, from 4,417,443 tons in 1910 to 3,129,332 tons in 1911. This decrease was in part made up, however, by an increase of approximately 200,000 tons in the production for other purposes and the total decrease amounted to 1,090,041 short tons, or 6.8 per cent. The decrease in value, somewhat less in proportion, was $1,156,904, or 5.7 per cent, from $20,236,853 to $19,079,949. The average price per ton advanced from $1.26 in 1910 to $1.27 in 1911.

The number of men employed in the coal mines of Alabama in 1911 was 22,707, who worked an average of 227 days, against 22,230 men, for an average of 249 days in 1910. The more working days in 1910 and the larger production in that year were due to the strike in Illinois and other Western States, and to low water in Ohio and Kanawha rivers, which reduced shipments from Pennsylvania and West Virginia to Mississippi River points. The average production per man in 1911 was 662 tons against 725 tons in 1910. The average daily production per man was 2.92 tons in 1910 and 3 tons in 1911. Most of the Alabama mines are worked 10 hours a day.

As in 1910, the coal mines of Alabama in 1911 were practically free from labor troubles, there having been only one instance of disaffection reported. In that case 210 men were idle six days. The supply of labor was adequate, and there was no complaint on account of the lack of transportation facilities.

The returns for 1911 show a decrease of 45 in the number of machines employed, 317 having been reported in 1910 and 272 in 1911. The production by machines decreased from 2,980,122 tons to 2,936,512 tons. The percentage of the machine-mined product to the total increased, however, from 18.5 in 1910 to 19.6 in 1911. In explanation of the decrease in the number of machines employed in 1911 in the coal mines of Alabama and in the quantity of coal mined by their use, there were 3 mines which reported a total of 27 machines in 1910, which were idle throughout the whole of 1911. Two other properties at which 7 machines were used in 1910 reported no machines used in 1911. One mine which reported 12 pick machines in 1910 used 2 continuous cutters in 1911, and another, which reported 16 machines in 1910, used but 13 in 1911.

The methods used in the mining of coal were reported by mines having a total production in 1911 of 14,233,483 tons, of which 4,673,719 tons were mined by hand, 2,936,512 tons were mined by machines, and 6,623,252 tons were shot from the solid. The mined coal (that is, the coal undercut by machines, added to that mined by hand) represented 53.5 per cent of the total, and that shot from the solid, 46.5 per cent. Exclusive of the coal mined by machinery, the percentage of coal shot from the solid was 58.6 and that mined by hand was 41.4 per cent. The quantity of Alabama coal washed in 1911, most of which was used in the manufacture of coke, was 6,251,828 short tons, yielding 5,538,401 tons of cleaned coal and 713,427 tons of refuse.

According to statistics compiled by the United States Bureau o Mines there were more men killed by explosions, including those fron windy shots, in the coal mines of Alabama in 1911 than in any othe State, the death roll from this cause in Alabama totaling 130, or mor than 30 per cent of all the deaths from this cause. The total numbe of men killed underground was 204, there being in addition to the 13 deaths from explosion, 47 from falls of roof or coal, 14 from haulag accidents, 5 from explosions of powder, and 8 from other causes One man was killed by shaft accident and 4 were killed on the surface The aggregate deaths from accidents above and below ground wer 209. The death rate per 1,000 employees was 9.2 and the numbe of tons mined for each life lost was 71,873.

The statistics of coal production in Alabama in 1910 and 1911, wit the distribution of the product for consumption, are shown in th following table:

Coal production of Alabama in 1910 and 1911, by counties, in short tons.

1910.

County.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Made into coke.	Total quantity.	Total value.	Average price per ton.	Average number of days active.	Average number of employees.
Bibb	1,462,720	6,961	110,883	....	1,580,564	$2,370,919	$1.50	261	2,666
Etowah	169,251	1,538	1,676	....	172,465	254,798	1.48	251	388
Jefferson	4,289,536	109,377	329,777	3,570,012	8,298,702	10,247,456	1.23	255	10,832
St. Clair	411,247	2,398	14,764	....	428,409	571,675	1.33	234	524
Shelby	450,324	3,381	34,436	....	488,141	780,887	1.60	253	847
Tuscaloosa	412,144	6,842	54,498	607,735	1,081,219	1,232,495	1.14	264	1,496
Walker	3,395,104	66,561	87,118	239,696	3,788,479	4,395,910	1.16	227	4,889
Winston	16,192	250	....	....	16,442	25,370	1.54	156	57
Other counties [a]	237,293	8,583	10,855	....	256,731	356,723	1.39	241	531
Small mines	....	310	....	....	310	620	2.00	....	....
Total	10,843,811	206,201	644,007	4,417,443	16,111,462	20,236,853	1.26	249	22,230

1911.

County.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Made into coke.	Total quantity.	Total value.	Average price per ton.	Average number of days active.	Average number of employees.
Bibb	1,515,976	9,592	107,629	....	1,633,197	$2,407,918	$1.47	239	2,631
Blount	80,266	1,900	100	....	82,266	98,599	1.20	225	189
Etowah	252,866	720	2,274	....	255,860	360,307	1.40	189	492
Jefferson	4,804,221	86,017	307,265	2,578,887	7,776,390	9,668,726	1.24	246	10,665
St. Clair	509,120	1,584	18,507	....	529,211	673,576	1.27	240	682
Shelby	430,505	2,723	29,861	....	463,089	757,772	1.64	240	866
Tuscaloosa	585,666	9,310	61,624	375,058	1,031,658	1,288,235	1.25	265	1,445
Walker	2,820,521	25,077	82,610	175,387	3,103,595	3,598,720	1.16	180	5,360
Winston	16,074	350	....	....	16,424	25,185	1.50	67	129
Other counties [b] and small mines	120,348	3,918	5,465	....	129,731	200,911	1.55	170	248
Total	11,135,563	141,191	615,335	3,129,332	15,021,421	19,079,949	1.27	227	22,707

[a] Blount, Cullman, Dekalb, Jackson, and Marion.

[b] Cullman, Dekalb, Jackson, and Marion.

In the following table is presented a statement of the production of coal in Alabama, by counties, during the last five years, with increases and decreases in 1911 as compared with 1910:

Coal production of Alabama, 1907–1911, by counties, in short tons.

County.	1907	1908	1909	1910	1911	Increase (+) or decrease (−), 1911.
Bibb	1,297,158	1,166,548	1,338,243	1,580,564	1,633,197	+ 52,633
Blount Cullman	[a] 336,308	[a] 181,062	[a] 186,261	[a] 235,456	[a] 210,070	− 25,386
Etowah	205,015	8,880	46,194	172,465	255,860	+ 83,395
Jefferson	7,526,275	5,914,129	7,176,922	8,298,702	7,776,390	− 522,312
St. Clair	283,806	193,434	354,005	428,409	529,211	+ 100,802
Shelby	245,087	407,547	524,925	488,141	463,089	− 25,052
Tuscaloosa	1,047,364	712,101	1,006,989	1,081,219	1,031,658	− 49,561
Walker	3,254,919	2,941,836	2,973,776	3,788,479	3,103,595	− 684,884
Winston	35,333	28,408	32,278	16,442	16,424	− 18
Other counties and small mines	19,189	50,648	63,857	21,585	1,927	− 19,658
Total	14,250,454	11,604,593	13,703,450	16,111,462	15,021,421	− 1,090,041
Total value	$18,405,468	$14,647,891	$16,306,236	$20,236,853	$19,079,949	−$1,156,904

[a] Includes production of Marion County.

So far as known, the earliest record of the existence of coal in Alabama was made in 1834. The first statement of production in the State is contained in the United States census report for 1840, in which year the production is given as 946 tons. The census report for 1850 does not mention any coal production for the State, and the next authentic record is contained in the census statistics of 1860, when Alabama is credited with an output of 10,200 short tons. The mines of Alabama were probably worked to a considerable extent during the Civil War, but there are no records of the actual production until 1870, for which year the United States census reports a production of 11,000 tons. Ten years later the production had increased to 323,972 short tons, but the development of the present great industry really began in 1881 and 1882, when attention was directed to the large iron deposits near the city of Birmingham, and thus the great "boom" of that city and vicinity was inaugurated. By 1885 the coal production of the State had increased to nearly 2,500,000 tons. Then followed a period of relapse and liquidation, which lasted two years, after which business settled down to a conservative and rational basis and has since developed steadily. In 1902 the coal production of the State reached a total of more than 10,000,000 tons, and reached the maximum of 16,111,462 tons in 1910.

The statistics of production in Alabama from 1840 to the close of 1911 are shown in the following table:

Production of coal in Alabama from 1840 to 1911, in short tons.

Year.	Quantity.	Year.	Quantity.	Year.	Quantity.	Year.	Quantity.
1840	946	1859	9,000	1878	224,000	1897	5,893,77
1841	1,000	1860	10,200	1879	280,000	1898	6,535,28
1842	1,000	1861	10,000	1880	323,972	1899	7,593,41
1843	1,200	1862	12,500	1881	420,000	1900	8,394,27
1844	1,200	1863	15,000	1882	896,000	1901	9,099,05
1845	1,500	1864	15,000	1883	1,568,000	1902	10,354,57
1846	1,500	1865	12,000	1884	2,240,000	1903	11,654,3
1847	2,000	1866	12,000	1885	2,492,000	1904	11,262,0
1848	2,000	1867	10,000	1886	1,800,000	1905	11,866,0
1849	2,500	1868	10,000	1887	1,950,000	1906	13,107,9
1850	2,500	1869	10,000	1888	2,900,000	1907	14,250,4
1851	3,000	1870	11,000	1889	3,572,983	1908	11,604,5
1852	3,000	1871	15,000	1890	4,090,409	1909	13,703,4
1853	4,000	1872	16,800	1891	4,759,781	1910	16,111,4
1854	4,500	1873	44,800	1892	5,529,312	1911	15,021,4
1855	6,000	1874	50,400	1893	5,136,935		
1856	6,800	1875	67,200	1894	4,397,178	Total	221,175,2
1857	8,000	1876	112,000	1895	5,693,775		
1858	8,500	1877	196,000	1896	5,748,697		

ALASKA.

Total production in 1911, 900 short tons; spot value, $7,200.

According to A. H. Brooks,[1] of the United States Geological Surve the commercial coal-mining operations in Alaska in 1911 were limite to those of one mine, but a little coal was taken out for local use various points in the Territory, and Mr. Brooks estimates the tot production at 900 tons. The following notes on the Alaskan develo ments and trade are taken from Mr. Brooks's report:

> The Chignik Coal Mining Co.[2] operated its mine, located on Thompson Creek abo 2 miles from tidewater at Chignik Bay. During 1910 and 1911 an entry about 1,0 feet long was driven at this mine. In this a roll was encountered which cut out t coal for 210 feet, but beyond which the bed was again picked up. The bed is sa

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[1] Brooks, Alfred H., Mineral resources of Alaska, 1911: Bull. U. S. Geol. Survey No. 520, 1912.

[2] The writer is indebted to Henry S. Tibbey, manager of the property, for information about devel ments.

to be 10 feet thick and to include 8 feet of coal, occurring in two benches separated by shale. A wagon road about 2 miles long has been built, which connects the mine with the wharf. Bunkers have been erected at the mine and at the wharf. Plans are under consideration to build either an aerial or a surface tram. The coal mined has been sold to local steamers and canneries. There was some coal mined along the beach at Cook Inlet. Much of this was picked below high tide and did not involve any actual excavation. There was probably also a little mining of coal in the Chicago Creek region of Seward Peninsula to supply some nearby placer camps. There were also some small enterprises of this kind in other parts of the Territory, about which no information is at hand.

Coal consumption of Alaska, by sources, 1899 to 1911, in short tons.

Year.	Imported from States, chiefly from Washington.		[b] Produced in Alaska, chiefly sub-bituminous and lignite.	[b] Total domestic.	[c] Total foreign coal, chiefly bituminous from British Columbia.	Total coal consumed.
	Bituminous.	Anthracite.				
1899	[a] 10,000	....	1,200	11,200	50,120	61,320
1900	15,048	....	1,200	16,248	56,623	72,871
1901	[a] 24,000	....	1,300	25,300	77,674	102,974
1902	[a] 40,000	....	2,212	42,212	68,363	110,575
1903	64,625	1	1,447	66,073	60,605	126,678
1904	36,689	....	1,694	38,383	76,815	115,198
1905	67,707	6	3,774	71,487	72,567	144,054
1906	68,960	533	5,541	75,034	47,590	122,624
1907	45,130	1,116	10,139	56,385	88,596	144,981
1908	23,402	491	3,107	27,000	72,831	99,831
1909	33,112	....	2,800	35,912	74,316	110,228
1910	32,138	....	1,000	33,138	73,904	107,042
1911	32,255	....	900	33,155	88,573	121,728
Total	493,066	2,147	36,314	531,527	908,577	1,440,104

[a] Estimated. [b] By calendar year. [c] By fiscal years ending June 30.

The annual coal consumption in Alaska is shown in the above table. In this it will be observed that there was an increase in the use of coal in 1911 compared with 1910. This is probably due to the amount used by the Copper River Railway, which began operating a regular train service during 1911. The consumption of 1912 will probably be considerably less, for oil is rapidly supplanting coal as fuel. Of the larger consumers of fuel in the Territory, the Copper River Railway, the majority of the ocean steamers, the Treadwell group of mines, most of the Yukon River boats, and 18 of the 24 dredges operated on Seward Peninsula, are using oil-consuming engines. The passenger service on the Tanana Valley and the Alaska Northern Railway is maintained by gasoline motor cars. The increased use of fuel oil and gasoline in Alaska is shown by the following table. These facts clearly indicate that the local market for Alaska coal is certainly not increasing.

The following table gives the shipments of petroleum products to Alaska from 1905 to 1911, inclusive:

Shipments of petroleum products to Alaska from other parts of the United States, 1905–1911, in gallons.

Year.	Crude.		Naphtha.		Illuminating.		Lubricating.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
1905	2,715,386	$91,068	713,496	$109,921	627,391	$113,921	83,319	$31,660
1906	2,688,100	38,409	580,978	100,694	568,033	109,964	83,992	32,854
1907	9,104,300	143,506	636,881	119,345	510,145	99,342	100,145	37,929
1908	11,891,375	176,483	939,424	147,104	566,598	102,567	94,542	36,423
1909	14,034,900	334,258	746,930	118,810	531,727	98,786	85,687	35,882
1910	18,835,670	477,673	788,154	136,569	626,972	95,483	104,512	38,625
1911	18,142,364	406,400	1,238,865	167,915	423,750	57,896	100,141	34,048

The following table shows the annual coal production of Alaska since 1897 and an estimate of the output between 1888 and 1897. A little coal was mined prior to 1884 by the crews of vessels that ran short of fuel, but this probably did not aggregate more than a few hundred tons. The total output of coal prior to 1889, including that mined by the Russians, was probably less than 10,000 tons.

Production of coal in Alaska, 1888–1911, in short tons.

Year.	Quantity.	Value.	Year.	Quantity.	Value.
1888–1896	6,000	$84,000	1905	3,774	$13,250
1897	2,000	28,000	1906	5,541	17,974
1898	1,000	14,000	1907	10,139	53,600
1899	1,200	16,800	1908	3,107	14,810
1900	1,200	16,800	1909	2,800	12,300
1901	1,300	15,600	1910	1,000	15,000
1902	2,212	19,048	1911	900	7,200
1903	1,447	9,782			
1904	1,694	7,225	Total	45,314	345,389

NOTE.—The production for 1888–1896 is estimated on the best data obtainable. The figures for 1897 to 1911 are based for the most part on data supplied by operators.

The possibilities of the development of a market for Alaskan coal, outside of the requirements for the United States Navy, are discussed in a review of the coal trade of the Pacific coast in the earlier pages of this report.

ARIZONA.

Arizona has not produced any coal on a commercial scale, although two areas of considerable extent are known to exist within the borders of the State. The more important of these is the Black Mesa field, in the Hopi and Navajo Indian reservations in Coconino, Navajo, and Apache counties. The region has not been studied in detail, but what little is known of it has been given publication in Survey Bulletin 431. M. R. Campbell, who made a reconnaissance examination of the field in 1911, estimates the area at 5,920 square miles and that it contains 8,000,000,000 tons of recoverable coal. In quality the coal is on the boundary line between bituminous and subbituminous. The smaller area known as the Deer Creek field is located in the extreme eastern end of Pinal County. It is described by Campbell in Survey Bulletin 225. This coal is bituminous and possesses some coking qualities. A third area of subbituminous coal near Pinedale, in the southern end of Navajo County, of less potential importance than the Deer Creek and Black Mesa regions, is described by A. C. Veatch in Survey Bulletin 431. The development of any or all of these areas will depend upon the advent of railroad facilities.

ARKANSAS.

Total production in 1911, 2,106,789 short tons; spot value, $3,396,849.

Compared with 1910, when the coal production of Arkansas amounted to 1,905,958 short tons, valued at $2,979,213, the output in 1911 showed an increase of 200,831 short tons, or 10.54 per cent, in quantity and of $417,636, or 14 per cent, in value, but was 270,000 tons less than the output of 1909 and nearly 570,000 tons less than that of 1907. The value of the 1911 production was more than $100,000 less than that of 1908 when the quantity of coal produced was nearly 30,000 tons less than the output of 1911. The coal-mining industry of Arkansas has not kept pace with the progress made in other States, for, while there have been some fluctuations, notably the exceptionally large tonnage in the boom year, 1907, production has not shown any actual gain in a decade in Arkansas. The output of 1903 exceeded that of 1911, which, indeed, was only 10,000 tons more than the average for the ten years from 1901 to 1910, inclusive. The increase in 1911 was not sufficient to make up for the losses in tonnage resulting from the strike of 1910, and the advance of 5 cents a ton in the average price per ton in 1911 was hardly sufficient to meet the increased cost of mining which followed the strike. Competition with fuel oil and with natural gas from the Mid-Continent field and with the more cheaply mined coals from Alabama, Colorado, Illinois, and Kentucky have narrowed down the markets for Arkansas and also for Oklahoma bituminous coals to comparatively local points, and the prospects of any expansion of trade in the near future are not bright. The only encouraging outlook at the present time is in the growing popularity of Arkansas semianthracite which, being a smokeless fuel and an excellent substitute for anthracite, is increasing in favor as a domestic fuel as far north as Kansas City, and the public in that section is beginning to realize the superiority of this fuel for household use.

Operators in both Arkansas and Oklahoma make vigorous protest against the high mining rates they are compelled to pay, and claim that the high cost of mining has placed the coals of those States at a disadvantage in trying to meet the competition of other fuels. The production thus restricted has, they say, reduced the working days to about 50 per cent of the possible working days in the year. This statement appears to be borne out by the statistics of 1911, for the average number of working days reported for Arkansas in that year was 133, considerably less than one-half of the number of possible working days, though slightly more than half the usual average made in the United States.

Another difficulty with which the operators in Arkansas and Oklahoma have to contend is the persistency of the miners in shooting coal off the solid, and this practice is certainly not discouraged by the law of Oklahoma that compels the payment for mining on the mine-run basis. Shooting off the solid, it is claimed, has increased the proportion of slack from 20 per cent (formerly a large percentage) to 40 per cent, which is now the minimum. It not only thus decreases the percentage of salable coal by increasing the quantity of fine coal and dust, but the lump coal is made more friable and more liable to break in handling and transportation. Moreover, the liability to explosions is materially increased.

The extent to which the reprehensible practice of shooting off the solid is carried in Arkansas is exhibited by the fact that out of a total of 2,106,789 tons of coal produced in 1911, 1,903,728 tons, or 90.4 per cent, were so mined; 27,029 tons, or 1.3 per cent, were mined by machines; and 131,596 tons, or 6.2 per cent, were mined by hand.

The method employed in mining 44,436 tons, or 2.1 per cent of the total, was not reported.

The number of men employed in the coal mines of Arkansas in 1911 was 5,657 against 5,568 in 1910. The average number of days worked (133) in 1911 was only 5 days more than the average for 1910 when the miners were on strike for nearly six months. The average production per man in 1911 was 372.4 short tons for the year and 2.8 tons per day. In 1910 the average production per man was 342 tons for the year and 2.67 per day.

The number of deaths in the coal mines of Arkansas in 1911, according to reports to the United States Bureau of Mines, was 12, of which 9 were due to falls of roof or coal. The death rate was 2.12 and the number of tons mined for each life lost was 175,566.

The mines of only one company were affected by strikes during 1911. There were 665 men idle, but in each case the difficulties were settled without much delay and the average number of days lost by the 665 men affected was 7.

The statistics of production, by counties, for 1910 and 1911, with the distribution of the product for consumption, are shown in the following table:

Coal production of Arkansas in 1910 and 1911, by counties, in short tons.

County.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Total quantity.	Total value.	Average price per ton.	Average number of days active.	Average number of employees.
1910.								
Franklin	281,025	2,300	13,400	296,725	$430,338	$1.45	132	772
Johnson	126,241	854	6,270	133,365	296,176	2.22	96	730
Logan	11,866	2,916	710	15,492	38,638	2.49	93	129
Sebastian	1,374,491	5,299	45,557	1,425,347	2,131,888	1.50	140	3,613
Other counties [a] and small mines	28,399	1,743	4,887	35,029	82,173	2.35	79	324
Total	1,822,022	13,112	70,824	1,905,958	2,979,213	1.56	128	5,568
1911.								
Franklin	401,081	2,560	17,950	421,591	$650,634	$1.54	184	851
Johnson	127,806	1,768	7,507	137,081	353,111	2.58	85	771
Logan	10,393	1,101	480	11,974	29,422	2.46	119	58
Sebastian	1,414,814	8,974	60,744	1,484,532	2,208,611	1.49	129	3,740
Other counties [a] and small mines	42,709	2,157	6,745	51,611	155,071	3.00	188	237
Total	1,996,803	16,560	93,426	2,106,789	3,396,849	1.61	133	5,657

[a] Pope, Scott, and Washington.

A statement of the production of coal in Arkansas, by counties, for the last five years, with increase and decrease in 1911 as compared with 1910, is shown in the following table:

Coal production of Arkansas, 1907–1911, by counties, in short tons.

County.	1907	1908	1909	1910	1911	Increase (+) or decrease (−), 1911.
Franklin	[a] 666,735	[a] 400,995	281,399	296,725	421,591	+ 124,866
Johnson	....	....	171,102	133,365	137,081	+ 3,716
Logan	29,970	30,723	25,169	15,492	11,974	− 3,518
Pope	47,753	35,481	56,344	13,240	45,935	+ 32,695
Sebastian	1,875,386	1,580,778	1,818,781	1,425,347	1,484,532	+ 59,185
Other counties and small mines	50,594	30,380	24,362	21,789	5,676	− 16,113
Total	2,670,438	2,078,357	2,377,157	1,905,958	2,106,789	+ 200,831
Total value	$4,473,693	$3,499,470	$3,523,139	$2,979,213	$3,396,849	+ $417,636

[a] Includes Johnson County.

According to the United States census for 1840, a small quantity of coal (220 short tons) was mined in Arkansas during that year. With the exception of 9,972 short tons mined in Missouri and 400 tons from Iowa mines, this was the only coal produced west of Mississippi River in that year, and for the next 20 years these were the only States west of the Mississippi from which any coal production was reported. The industry in Arkansas did not develop rapidly during the earlier years, as the census of 1860 shows a production of only 200 tons and that of 1880 a total of 14,778 short tons. From 1881 to 1902 production increased quite regularly, but for the last 10 years has remained practically stationary. The maximum of 2,670,438 short tons was attained in 1907.

The annual production of coal in Arkansas from 1840 to the close of 1911 will be found in the following table:

Production of coal in Arkansas from 1840 to 1911, in short tons.

Year.	Quantity.	Year.	Quantity.	Year.	Quantity.	Year.	Quantity.
1840	220	1887	129,600	1896	675,374	1905	1,934,673
1860	200	1888	276,871	1897	856,190	1906	1,864,268
1880	14,778	1889	279,584	1898	1,205,479	1907	2,670,438
1881	20,000	1890	399,888	1899	843,554	1908	2,078,357
1882	25,000	1891	542,379	1900	1,447,945	1909	2,377,157
1883	50,000	1892	535,558	1901	1,816,136	1910	1,905,958
1884	75,000	1893	574,763	1902	1,943,932	1911	2,106,789
1885	100,000	1894	512,626	1903	2,229,172		
1886	125,000	1895	598,322	1904	2,009,451	Total	32,224,662

CALIFORNIA.

Total production in 1911, 10,747 short tons; spot value, $16,097.

On account of the great increase in the production and use of petroleum in California, coal mining has practically ceased. Its revival will depend either upon a decided decline in the supply of fuel oil, or in a marked advance in price which will make coal attractive as a railroad and manufacturing fuel. There does not appear to be much chance of either in the near future. The only production of coal in California in 1911 was in Amador and Monterey counties, lignite in the former, representing more than nine-tenths of the total production, bituminous coal in the latter representing less than one tenth. The total production was 10,747 short tons. The production of petroleum in California in 1911 was 81,000,000 barrels, of which not less than 50,000,000 barrels were used directly for fuel. Large quantities are also used in place of coal for gas making, and estimating 3½ barrels of petroleum as equivalent to 1 ton of ordinary bituminous coal, it is probable that from 20,000,000 to 25,000,000 tons of coal would be required to perform in California the service now rendered by petroleum in the production of heat, light, and power. California oil is the principal fuel for locomotives as far north as Washington and across the Sierras and the Cascades, its freedom from sparks serving as a great protection against forest fires, as compared with coal or wood fuel. It is used almost exclusively on inland and coastwise steamers, and to an increasing extent by the trans-Pacific steamers. It has even displaced coal on Puget Sound, many of the steamers of the Canadian Pacific fleet plying between Vancouver, Victoria, and other points having been equipped for oil burning. These conditions are discussed at length in the review of the coal trade of the Pacific coast in the section devoted to coal trade reviews. There is still, however, some demand for coal, particularly for domestic use in California and for bunker trade at San Francisco, but this is almost exclusively supplied by coals from other States—Washington, Utah, Wyoming, and New Mexico—and from foreign countries, chiefly British Columbia, with small quantities of anthracite and high-grade bituminous coals from the Eastern States. The railroads entering California brought from the Rocky Mountain States in 1911 a total of 229,702 short tons; the receipts by water at San Francisco from Oregon, Washington, and Eastern States were 162,484 short tons; and the imports into San Francisco, Los Angeles, and San Diego, reported by the Bureau of Statistics of the Department of Commerce and Labor, were 312,824 short tons, a total of 705,010 short tons. The total production of coal in California in 1911 was therefore only abaut 1.5 per cent of the consumption.

The statistics of coal production in California during the last six years, with the distribution of the product for consumption, are shown in the following table:

Distribution of the coal product of California, 1906–1911, in short tons.

Year.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Total quantity.	Total value.	Average price per ton.	Average number of days active.	Average number of employees.
1906	7,040	15,250	3,000	[a] 25,290	$60,710	$2.40	284	41
1907	7,910	2,680	3,360	13,950	38,213	2.74	258	32
1908	12,400	1,955	4,400	18,755	54,840	2.93	250	34
1909	34,888	3,297	7,651	45,836	95,042	2.07	....	14
1910	6,679	3,985	500	11,164	18,336	1.64	192	14
1911	4,981	5,266	500	10,747	16,097	1.50	254	45

[a] In addition to this total there were 6,910 tons of bituminous coal mined in Monterey County, but not shipped during the year.

Production of coal in California from 1861 to 1911, in short tons.

Year.	Quantity.	Year.	Quantity.	Year.	Quantity.	Year.	Quantity.
1861	6,620	1875	166,638	1889	119,820	1903	104,673
1862	23,400	1876	128,049	1890	110,711	1904	78,888
1863	43,200	1877	107,789	1891	93,301	1905	77,050
1864	50,700	1878	134,237	1892	85,178	1906	25,290
1865	60,530	1879	147,879	1893	72,603	1907	13,950
1866	84,020	1880	236,950	1894	67,247	1908	18,755
1867	124,690	1881	140,000	1895	75,453	1909	45,836
1868	143,676	1882	112,592	1896	78,544	1910	11,164
1869	157,234	1883	76,162	1897	87,992	1911	10,747
1870	141,890	1884	77,485	1898	145,888		
1871	152,493	1885	71,615	1899	160,915	Total	5,117,447
1872	190,859	1886	100,000	1900	171,708		
1873	186,611	1887	50,000	1901	151,079		
1874	215,352	1888	95,000	1902	84,984		

COLORADO.

Total production in 1911, 10,157,383 short tons; spot value, $14,747,764.

Colorado is the principal coal-producing State west of Mississippi River and ranks seventh in this regard among all the States. The grades of coal produced range from subbituminous coal to anthracite, though the supply and production of the latter, while interesting, are insignificant compared with that of Pennsylvania. Colorado's record in coal production was made in 1910, when it reached a total of nearly 12,000,000 short tons, the actual output being 11,973,736 short tons. An unusually mild winter in 1910–11, a prolonged drought in the agricultural States of the Great Plains region, a decreased consumption of locomotive fuel, and the resumption of mining in the coal States of the Mississippi Valley, all contributed to a marked reaction from the fat year, 1910, and, as in the other Rocky Mountain States, the coal production in Colorado fell off sharply. The tonnage won in Colorado in 1911 was less than the average of the five preceding years. Compared with 1910, when the production amounted to 11,973,736 short tons, valued at $17,026,934, the output in 1911 showed a decrease of 1,816,353 short tons, or 15 per cent, in quantity and of $2,279,170, or 13 per cent, in value. Only four counties showed increased production, Boulder, Weld, Delta, and Routt. The first two constitute the Denver subbituminous region, in which many of the miners were on strike in 1910, and those counties were exceptions in a year of generally increased production in the State. Industrial peace was restored in 1911, and Boulder County increased its production 151,983 tons, but did not attain the records made in any of the four years preceding 1910. Weld County increased its production 197,500 tons, or over 60 per cent, and reached its highest point. Routt County is becoming one of the important producers, the development of its rich coal areas following the completion (in 1909) of the Denver, Northwestern and Pacific Railway. Routt County in 1907 produced only a little over 5,000 tons for local use; in 1911 its production was 317,791 tons, an increase over 1910 of 59,339 tons. Delta County is relatively unimportant. The counties suffering the largest losses in 1911 were Las Animas (decrease 1,089,332 tons) and Huerfano (600,436 tons). The former is the only county which produces coking coal to any extent, and 25 per cent of the decrease in 1911 was in the coal made into coke. Las Animas County, which contains the Colorado portion of the Trinidad-Raton coal field, produced 40 per cent of the State's total in 1911, and sustained 60 per cent of the total decrease. In 1910 it was credited with 75 per cent of the total increase.

The number of men employed in the coal mines of Colorado in 1911 was 14,316, who worked an average of 207 days, against 15,864 men for 236 days in 1910. The average production per man was 709.5 tons in 1911 against 755 tons in 1910. The average daily production was 3.42 tons against 3.2 tons in 1910.

Notwithstanding the decrease of 15 per cent in the total quantity of coal produced in Colorado in 1911, compared with 1910, and also despite a decrease of 14 (from 256 to 242) in the number of mining machines employed, the production by the use of machines increased from 1,905,781 tons in 1910 to 1,975,411 tons in 1911. In 1911 the machine-mined tonnage was equivalent to 19.45 per cent of the total output, as against 15.99 per cent in 1910. The pick or puncher type of machine is apparently in greatest favor, there having been 157 of that type in use during 1911. The remainder was made up of 26 chain-breast, 34 long-wall, 17 short-wall, and 8 radialaxe or post-puncher type.

In reply to inquiries concerning the percentage of coal mined by hand, shot from the solid, and undercut by machines, reports were received from operators representing 90 per cent of the total production of the State, or a little over 9,000,000 tons. It is gratifying to note that the quantity of coal shot from the solid represented only 14 per cent of this total. The quantity of coal mined by machines represented 21.8 per cent, and that mined by hand represented 64.2 per cent. The quantity of coal mined by hand was more than four and one-half times that shot from the solid, the figures being, respectively, 5,822,282 tons mined by hand, and 1,260,191 tons shot from the solid.

There were only three instances in which labor disaffections were reported during 1911. In one the mines were idle throughout the year; in the second 25 men were idle 75 days; and in the third 35 men were idle 100 days. All of these were in the subbituminous region of Boulder County.

It is possibly not out of place to call attention to the close agreement between the reports of coal production in Colorado published by the State coal mine inspector and the figures compiled by the United States Geological Survey. The State coal mine inspector gives the total production in 1911 as 10,075,861 short tons. The returns to the Survey show a total output of 10,157,383 tons, the difference (81,522 tons) being probably due to the production of small mines, which do not come under the mine inspection law, but whose output is reported to the Survey. The production of coal in Colorado at mines which produced less than 5,000 tons in 1911 amounted to 84,986 tons. The practical agreement of the two sets of statistics bears witness to the accuracy of both.

According to returns to the United States Bureau of Mines, there were 91 deaths charged to coal-mining accidents in Colorado in 1911—84 below ground, 2 in shafts, and 5 on the surface. Of the 84 deaths underground 47 were due to falls of roof or coal, 12 to mine cars and motors, 18 to explosions of gas or dust, 1 to an explosion of powder, and 6 to other causes. The death rate per thousand of employees was 6.35, and the number of tons mined for each life lost was 111,619.

The statistics of production in Colorado in 1910 and 1911, with the distribution of the product for consumption, are shown in the following table:

Coal production of Colorado in 1910 and 1911, by counties, in short tons.

1910.

County.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Made into coke.	Total quantity.	Total value.	Average price per ton.	Average number of days active.	Average number of employees.
Boulder	748,528	13,155	41,086	....	802,769	$1,235,463	$1.54	159	1,502
Delta	55,203	8,037	350	....	63,590	107,290	1.69	249	71
El Paso	196,225	129,769	10,786	....	336,780	453,877	1.35	278	379
Fremont	678,948	14,475	28,719	....	722,142	1,627,567	2.25	215	1,403
Garfield	177,324	5,474	6,957	....	189,755	286,017	1.51	157	271
Gunnison	571,469	3,919	20,794	44,800	640,982	994,511	1.55	211	862
Huerfano	2,310,565	7,320	69,205	....	2,387,090	3,956,794	1.66	227	3,188
La Plata	135,649	10,681	1,425	....	147,755	252,052	1.71	231	192
Las Animas	3,756,141	39,631	109,645	1,642,668	5,548,085	6,469,805	1.17	266	6,547
Mesa	103,285	23,729	2,516	....	129,530	188,618	1.46	211	151
Routt	248,760	2,664	7,028	....	258,452	437,979	1.69	256	355
Weld	286,556	21,968	14,372	....	322,896	460,758	1.43	185	486
Other counties[a]	294,410	9,644	17,634	97,524	419,212	547,655	1.31	278	457
Small mines	....	4,698	....	....	4,698	8,548	1.82	....	....
Total	9,563,063	295,164	330,517	1,784,992	11,973,736	17,026,934	1.42	236	15,864

1911.

County.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Made into coke.	Total quantity.	Total value.	Average price per ton.	Average number of days active.	Average number of employees.
Boulder	898,308	13,675	42,769	....	954,752	1,599,710	1.68	177	1,269
Delta	54,692	16,257	450	....	71,399	125,133	1.75	230	77
El Paso	226,078	94,822	11,255	....	332,155	434,353	1.31	263	360
Fremont	616,068	19,951	25,221	....	661,240	1,476,760	2.23	189	1,435
Garfield	145,138	12,698	8,072	....	165,908	230,593	1.39	248	191
Gunnison	517,149	2,302	21,079	35,118	575,648	856,168	1.31	210	785
Huerfano	1,700,377	12,885	73,392	....	1,786,654	2,994,481	1.67	191	2,973
La Plata	85,103	10,310	1,336	....	96,749	166,538	1.72	207	161
Las Animas	2,924,569	50,267	94,784	1,389,133	4,458,753	5,206,556	1.17	228	5,563
Mesa	67,634	25,247	....	....	92,881	156,046	1.68	217	130
Routt	305,361	1,830	10,600	....	317,791	563,306	1.77	139	639
Weld	469,484	23,883	27,029	....	520,396	760,476	1.46	258	572
Other counties[b]	94,751	7,951	8,960	....	111,662	157,830	1.41	196	161
Small mines	....	11,395	....	....	11,395	19,814	1.74	....	....
Total	8,104,712	303,473	324,947	1,424,251	10,157,383	14,747,764	1.45	207	14,316

[a] Archuleta, Jackson, Jefferson, Larimer, Pitkin, and Rio Blanco.

[b] Archuleta, Jefferson, Larimer, Montezuma, Pitkin, and Rio Blanco.

The statistics of production, by counties, during the last five years, with increase and decrease in 1911 as compared with 1910, are given in the following table:

Coal production in Colorado, 1907–1911, by counties, in short tons.

County.	1907	1908	1909	1910	1911	Increase (+) or decrease (−) 1911.
Boulder	1,296,729	1,067,948	1,332,322	802,769	954,752	+ 151,983
Delta	22,087	37,689	55,031	63,590	71,399	+ 7,809
El Paso	269,795	317,763	312,233	336,780	332,155	− 4,625
Fremont	784,949	669,274	611,980	722,142	661,240	− 60,902
Garfield	220,040	220,099	257,796	189,755	165,908	− 23,847
Gunnison	576,859	503,140	598,463	640,982	575,648	− 65,334
Huerfano	1,797,790	1,644,068	1,915,910	2,387,090	1,786,654	− 600,436
Jefferson	193,814	163,624	195,809	227,744	1,187	− 226,557
La Plata	184,018	166,090	139,858	147,755	96,749	− 51,006
Las Animas	4,885,105	4,190,801	4,592,964	5,548,085	4,458,753	− 1,089,332
Pitkin	313,866	228,828	159,753	183,068	101,773	− 81,295
Routt	5,690	13,005	92,439	258,452	317,791	+ 59,339
Weld	136,074	343,414	327,545	322,896	520,396	+ 197,500
Other counties [a]	103,420	69,230	124,833	142,628	112,978	− 29,650
Total	10,790,236	9,634,973	10,716,936	11,973,736	10,157,383	− 1,816,353
Total value	$15,079,449	$13,586,988	$14,296,012	$17,026,934	$14,747,764	−$2,279,170

[a] Includes small mines.

Coal mining as an industry in Colorado began in 1864, a production of 500 short tons being recorded in that year. In 1876 the production reached for the first time a total exceeding 100,000 tons, and six years later, in 1882, it had reached the million-ton mark. Since that date the increase has been almost uninterrupted, there being only fou times prior to 1911 (in 1884, 1894, 1904, and 1908) when the production showed a decrease of any importance, and only five times altogether in 38 years. The largest decrease was in the "hard-times' year, 1894. The coal production of the State exceeded 3,000,00 tons in 1890; 10 years later it had grown to over 5,000,000 tons and in 1910 it exceeded 11,000,000 tons, but in 1911 it declined t 10,157,383 tons.

The record, by years, since 1864 is shown in the following table:

Production of coal in Colorado from 1864 to 1911, in short tons.

Year.	Quantity.	Year.	Quantity.	Year.	Quantity.	Year.	Quantity
1864	500	1877	160,000	1890	3,077,003	1903	7,423,6
1865	1,200	1878	200,630	1891	3,512,632	1904	6,658,3
1866	6,400	1879	322,732	1892	3,510,830	1905	8,826,4
1867	17,000	1880	462,747	1893	4,102,389	1906	10,111,2
1868	10,500	1881	706,744	1894	2,831,409	1907	10,790,2
1869	8,000	1882	1,061,479	1895	3,082,982	1908	9,634,9
1870	4,500	1883	1,229,593	1896	3,112,400	1909	10,716,9
1871	15,600	1884	1,130,024	1897	3,361,703	1910	11,973,7
1872	68,540	1885	1,356,062	1898	4,076,347	1911	10,157,3
1873	69,997	1886	1,368,338	1899	4,776,224		
1874	77,372	1887	1,791,735	1900	5,244,364	Total..	155,151,3
1875	98,838	1888	2,185,477	1901	5,700,015		
1876	117,666	1889	2,597,181	1902	7,401,343		

GEORGIA.

Total production in 1911, 165,210 short tons; spot value, $246,20

Coal production in Georgia has shown a declining tendency for t last 8 years, the only exception to annually decreasing producti since 1903 having been recorded in 1907, when coal mining, in sympathy with the inflated industrial condition, was on a "boom." Scarcity of labor due to the withdrawal of the State convicts who had been leased to the mining companies and the inability to secure free labor to take their places is the only cause for the decreasing output. The mining district is somewhat isolated, and good and sufficient mining labor is naturally difficult to secure. The production in 1911 was the smallest since 1885, or in more than a quarter of a century, and was less than half of what it was in 1907. Compared with 1910, when the production amounted to 177,245 short tons, valued at $259,122, the output in 1911 showed a decrease of 12,035 short tons, or 6.79 per cent, in quantity and of $12,914, or 4.98 per cent, in value. The average price per ton advanced from $1.46 in 1910 to $1.49 in 1911, both of these being the highest in recent years, and indicating that the decreased production is not due to unfavorable trade conditions. At one establishment the slack coal used for coke making is washed before being charged into the ovens. In 1911, 111,579 tons were washed, yielding 83,327 tons of cleaned coal and 28,252 tons of refuse.

The statistics of the production of coal for the last five years, with the distribution of the product for consumption, are shown in the following table:

Coal production of Georgia, 1907–1911, in short tons.

Year.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Made into coke.	Total quantity.	Total value.	Average price per ton.	Average number of days active.	Average number of employees.
1907	204,890	5,780	10,700	141,031	362,401	$499,686	$1.38	262	808
1908	184,040	930	8,400	71,452	264,822	364,279	1.38	261	670
1909	119,806	1,000	4,100	86,290	211,196	298,792	1.41	....	460
1910	94,330	776	2,760	79,379	177,245	259,122	1.46	265	386
1911	86,141	957	5,435	72,677	165,210	246,208	1.49	278	510

The annual and total production since 1860 are shown in the following table:

Annual production of coal in Georgia, 1860–1911, in short tons.

Year.	Quantity.	Year.	Quantity.	Year.	Quantity.	Year.	Quantity.
1860	1,900	1874	60,000	1888	180,000	1902	414,083
1861	2,500	1875	80,000	1889	225,934	1903	416,951
1862	3,500	1876	110,000	1890	228,337	1904	383,191
1863	6,000	1877	120,000	1891	171,000	1905	351,991
1864	10,000	1878	128,000	1892	215,498	1906	332,107
1865	10,000	1879	140,000	1893	372,740	1907	362,401
1866	8,000	1880	154,644	1894	354,111	1908	264,822
1867	8,000	1881	168,000	1895	260,998	1909	211,196
1868	10,000	1882	160,000	1896	238,546	1910	177,245
1869	12,000	1883	155,000	1897	195,869	1911	165,210
1870	15,000	1884	150,000	1898	244,187		
1871	20,000	1885	150,000	1899	233,111	Total	8,942,169
1872	25,000	1886	223,000	1900	315,557		
1873	40,000	1887	313,715	1901	342,825		

IDAHO.

Total production in 1911, 1,805 short tons; spot value, $4,808.

The small production in Idaho is from a few scattered lignite beds and is used locally. The output of 1,805 tons in 1911 was the smallest in recent years.

The production in Idaho during the last six years has been as follows:

Coal production in Idaho, 1906–1911, in short tons.

Year.	Quantity.	Value.	Year.	Quantity.	Value.
1906	5,365	$18,538	1909	4,553	$19,459
1907	6,508	26,494	1910	4,448	17,426
1908	5,429	21,832	1911	1,805	4,808

ILLINOIS.

Total production in 1911, 53,679,118 short tons; spot value, $59,519,478.

As Illinois was the storm center in the strike of 1910, and was by far the largest producer of coal among all of the States affected, it naturally suffered the largest loss in tonnage, though all of the other States except Iowa suffered heavier percentages of loss. In its recovery from the effects of the strike, Illinois far outstripped the neighboring States, in the quantity of increased production. Moreover, Illinois established a new record for tonnage, exceeding the previous maximum of 1907 by over 2,350,000 tons. Compared with 1910, when the production amounted to 45,900,246 tons, the output in 1911 (53,679,118 tons) shows an increase of 7,778,872 tons, or 16.9 per cent. The value increased somewhat less in proportion, from $52,405,897 to $59,519,478, a gain of $7,113,581 or 13.57 per cent. In the preliminary review of the coal trade in 1911, published in the closing week of that year, it was estimated that the price of Illinois coal, notwithstanding the advance in wages following the settlement of the strike was estimated to have declined 3 cents a ton. The statistics collected by the United States Geological Survey in cooperation with the Illinois Geological Survey show that the average price declined from $1.14 to $1.11. It is true that on account of the scarcity of fuel during, and for some time after the strike of 1910, prices for coal in all of the States of the Middle Wes were considerably advanced, the average for Illinois being 9 cent higher than in 1908 and 1909, and, with the largely increased tonnag in 1911, the decline in price was natural and not indicative of an unsettlement of values.

The coals of Illinois are noncoking and are not used to any exten in the iron and steel industry. Consequently coal mining in the Stat was not influenced by the depression in the iron trade which so seriously reduced coal production in the Eastern States. Illinois is however, one of the most important manufacturing States, rankin third in this particular among the Commonwealths. Illinois lead all of the States of the Union in the manufacture of agricultura implements, and in the salting and packing of meats. It is secon in the manufacture of men's clothing, and, although without iron mines, is third in the value of manufactured iron and steel products. Its manufacturing industries have been developed and are maintained by the great coal resources of the State. They furnish the local markets for the coal and enable the producers to obtain a higher price than those obtained for the superior grades of coal from West Virginia, which depend almost entirely on distant markets. The average price of West Virginia coal (large quantities of which are shipped to Chicago and other points near to the Illinois coal fields) was 90 cents in 1911. That for Illinois coal was $1.11.

There are more counties producing coal in Illinois than in any other State in the Union, 51 counties out of a total of 102 (just 50 per cent) reporting some coal produced in 1911. Two counties in the State, Williamson and Sangamon, produce over 5,000,000 tons each; one, Macoupin, exceeds 4,000,000 tons; and each of five others, Franklin, Madison, St. Clair, Saline, and Vermilion, produces over 3,000,000 tons. One of these counties, Franklin, practically doubled its output in 1911, increasing from 1,778,768 tons in 1910 to 3,555,586 tons, the increase in 1911 being within 2,000 tons of the production in 1910. Other notable increases in 1911 were in Williamson County, 1,993,657 tons; Saline, County, 1,360,760 tons; Vermilion County, 869,950 tons; and Macoupin County, 833,983 tons. The principal decreases in 1911 were sustained by St. Clair County, whose production fell off 1,857,088 tons, or nearly one-third, and Madison County, which decreased 950,068 tons, or nearly one-fourth.

The coal miners of Illinois are probably better organized than those of any other bituminous coal-mining State. One result of this has been the establishment throughout the coal-mining regions of the eight-hour day. But the biyearly shutdown has naturally resulted in long beriods of idleness and loss of income both to operators and to employees. In 1906 practically all of the important mines were shut down, and 49,792 men out of a total of 61,988 were idle for an average of 58 days each. This was equivalent to an average of 48 days of idleness for each of the 61,988 employees, and was equal to 25 per cent of the total time made. In 1908 the suspension was not of such long duration nor were quite as many men affected, 47,456 men out of a total of 68,035 being idle for an average of 37 days, equivalent to an average idleness of 26 days for each of the 68,035 employees, and equal to 14 per cent of the total number of days worked by each man during the year. In 1910, out of a total of 72,645 men, 67,218 were idle for an average of 136 days, and the total time lost was equivalent to 9,133,953 working days. The total time made by the 72,645 men employed was 11,612,966 days, or an average of 160 days each. The idle time in 1910 was nearly 80 per cent of the working time made.

In 1911 the time lost by strikes was negligible, the total number of men on strike during the year being 5,543, who lost an average of 18 days. The total number of men employed in 1911 was 76,600, who worked an average of 188 days, against 72,645 men for an average of 160 days in 1910. It is to be noted that in 1911 when the mining operations were practically undisturbed by strikes, the average time made was only 28 days more than in 1910 when more than 90 per cent of the men were idle for an average of 136 days and when the total idle time was equal to nearly 80 per cent of the working time. The average production per man in Illinois in 1911 was 701 tons against 632 tons in 1910. The average daily production by each employee was 3.7 tons in 1911 and 3.95 tons in 1910.

One of the apparent results of the prolonged strike in 1910 was the marked increase in 1911 in the tonnage of coal won by machines. The increase in machine-mined tonnage was from 17,730,298 short tons in 1910 to 23,093,807 tons in 1911, a gain of 5,363,509 tons, or 30 per cent. The increase in machine-mined coal was equal to 70 per cent of the total increase in the State. It is to be hoped that the increasing use of and production by machines will have a reducing effect on the quantity of coal shot off the solid, of which the proportion to the total is unfortunately large in Illinois.

Of the total production of 53,679,118 short tons in 1911, mines producing 50,652,077 short tons, or about 94 per cent of the total, reported the mining methods employed. As already stated, 23,093,807 tons, or 45.6 per cent of the total were mined by the use of machines. The quantity shot off the solid was 20,433,262 short tons, or 40.3 per cent Of the quantity for which mining methods were reported, 7,125,008 tons, or 14.1 per cent, were undercut by hand Exclusive of the machine-mined tonnage and of the tonnage not reported, the proportion of coal shot off the solid was 74.1 per cent, and that undercut by hand was 25.9 per cent. The natural conditions in the Illinois coal field are favorable to the use of machines for the undercutting of coal, and the statistics for 1911 indicate a determination on the part of the operators to get away from the pernicious and dangerous practice of shooting from the solid. The number of mining machines employed in the coal mines of Illinois in 1911 was 1,402, compared with 1,361 in 1910, an increase of 41. The machines included 780 punchers, 555 chain-breast, 20 long-wall, and 47 short-wall or continuous cutters. As all of the coals lie practically level there is no inducement for the introduction of the radialaxe or post-puncher type of machine.

The fatality record in the coal mines of Illinois in 1911 was encouragingly reduced, the deaths from accident being considerably less than half those of the preceeding year. The number of men killed in the calendar year 1911 as reported to the Bureau of Mines was 172 against 390 as reported for the fiscal year 1910 by the State bureau of labor statistics. Of the 172 men killed in 1911, 153 were underground, 12 in shafts, and 7 on the surface. The 153 fatalities underground included 86 from falls of roof and coal (just one-half the total deaths) and 40 from haulage-way accidents. A windy shot killed 1, explosions of powder 13, and other causes 13. The death rate per thousand employees was 2 25 and the number of tons mined for each fatality was 312,088

Considerable quantities of the Illinois product are washed in preparation for the domestic trade. Usually the coal to be washed is sized before washing, and the larger part of the coal washed is nut coal, which is a popular domestic size. During 1911 the quantity of Illinois coal which was washed was 2,553,381 short tons, which yielded 2,154,697 tons of cleaned coal and 398,684 tons of refuse.

The statistics of production, by counties, in 1910 and 1911, with the distribution of the product for consumption, are shown in the following table:

Coal production of Illinois in 1910 and 1911, by counties, in short tons.

1910.

County.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Made into coke.	Total quantity.	Total value.	Average price per ton.	Average number of days active.	Average number of employees.
Bureau	867.063	63.626	42.657	....	973.346	$1.488.070	$1.53	157	3,294
Christian	1,058,371	102,620	62,304	....	1,223,295	1,322,162	1.08	134	1,912
Clinton	891,542	16,686	42,015	....	950,243	1,092,752	1.15	186	1,290
Franklin	1,694,295	23,257	61,216	....	1,778,768	2,312,342	1.30	133	2,882
Fulton	1,611,261	66,469	43,797	....	1,721,527	2,253,307	1.31	145	3,418
Gallatin	55,927	10,875	1,720	1,569	70,091	85,000	1.21	154	127
Grundy	547,231	33,960	19,090	....	600,281	968,563	1.61	131	2,257
Henry	78,431	42,746	3,066	....	124,243	225,018	1.81	228	235
Jackson	494,726	41,863	47,651	....	584,240	776,363	1.33	123	1,128
Knox	....	27,549	746	....	28,295	54,174	1.91	200	81
La Salle	839,173	290,656	49,056	....	1,178,885	2,032,002	1.72	171	3,171
Livingston	105,208	49,625	8,065	....	162,898	262,056	1.61	135	413
Logan	337,604	50,230	21,410	....	409,244	469,657	1.15	152	788
McDonough	9,252	16,843	243	....	26,338	61,194	2.32	181	88
Macon	116,471	110,306	8,584	....	235,361	387,713	1.65	177	492
Macoupin	3,665,759	63,399	125,071	....	3,854,229	3,479,049	.90	176	4,570
Madison	3,878,517	134,741	89,515	....	4,102,773	4,222,078	1.03	202	3,924
Marion	760,588	24,595	27,690	....	812,873	801,117	.99	152	1,256
Marshall	213,590	44,545	9,312	....	267,447	466,724	1.75	159	1,032
Menard	278,225	43,698	10,634	....	332,557	464,375	1.40	199	512
Mercer	201,081	19,025	8,918	....	229,024	343,115	1.50	138	560
Montgomery	1,709,995	50,284	39,441	....	1,799,720	1,907,006	1.06	159	2,374
Peoria	683,440	113,232	13,923	....	810,595	1,042,478	1.29	157	1,463
Perry	1,303,716	22,940	41,115	....	1,367,771	1,411,553	1.03	157	2,310
Randolph	973,761	26,544	25,252	....	1,025,557	1,065,969	1.04	200	1,165
Rock Island	13,449	50,766	1,992	....	66,207	109,433	1.65	179	79
St. Clair	5,417,001	241,940	129,626	....	5,788,567	5,763,249	1.00	195	5,598
Saline	2,389,033	30,811	39,806	....	2,459,650	2,713,514	1.10	134	4,248
Sangamon	4,076,071	246,223	127,340	....	4,449,634	5,014,237	1.13	151	7,099
Shelby	105,504	24,893	5,275	....	135,672	179,291	1.32	137	354
Stark	14,630	17,302	650	....	32,582	53,056	1.63	216	56
Tazewell	90,800	62,166	2,693	....	155,659	210,824	1.35	174	327
Vermilion	2,251,534	215,893	47,823	....	2,515,250	2,691,574	1.07	205	3,540
Williamson	4,354,824	57,281	195,286	12,981	4,626,372	5,086,928	1.10	133	8,050
Other counties[a] and small mines.	730,657	229,025	47,370	....	1,007,052	1,589,954	1.54	150	2,522
Total	41,818,730	2,666,614	1,400,352	14,550	45,900,246	52,405,897	1.14	160	72,645

1911.

Bureau	1,503,394	66,226	59,068	....	1,628,688	$2,569,897	$1.58	219	3,873
Christian	1,061,568	98,891	61,800	....	1,222,259	1,211,196	.99	132	2,158
Clinton	867,177	11,465	42,583	....	921,225	896,667	.97	160	1,292
Franklin	3,425,108	28,922	101,556	....	3,555,586	3,781,363	1.07	206	4,064
Fulton	2,026,679	59,325	47,025	....	2,133,029	2,706,871	1.27	174	3,693
Gallatin	50,227	11,443	1,338	....	63,008	71,588	1.14	167	138
Grundy	709,403	28,505	38,892	....	776,800	1,254,323	1.61	220	1,865
Henry	52,118	35,962	2,642	....	90,722	156,560	1.73	193	183
Jackson	545,892	86,410	55,451	....	687,753	906,645	1.32	147	1,140
Knox	....	28,832	1,304	....	30,136	53,620	1.78	186	83
La Salle	1,251,017	286,668	72,785	....	1,610,470	2,676,710	1.66	223	3,547
Livingston	46,536	39,380	3,507	....	89,423	139,675	1.56	149	341
Logan	259,014	49,896	25,950	....	334,860	388,724	1.16	124	680
McDonough	1,939	6,056	32	....	8,027	17,822	2.22	189	37
Macon	118,084	110,334	7,785	....	236,203	369,591	1.56	200	610
Macoupin	4,490,380	67,382	130,450	....	4,688,212	4,436,723	.95	201	4,638
Madison	2,954,710	118,381	79,614	....	3,152,705	3,094,573	.98	154	4,109
Marion	998,215	187,324	38,787	....	1,224,326	1,237,569	1.01	184	1,664
Marshall	384,679	20,301	19,004	....	423,984	705,130	1.66	218	1,051
Menard	146,739	36,126	7,612	....	190,477	221,786	1.16	194	343
Mercer	267,845	17,417	12,290	....	297,552	421,922	1.42	168	599
Montgomery	2,295,420	37,622	62,772	....	2,395,814	2,395,461	1.00	191	2,740
Peoria	924,951	86,641	25,770	....	1,037,362	1,285,259	1.24	208	1,477
Perry	1,213,576	17,103	41,613	....	1,272,292	1,216,946	.96	139	2,122
Randolph	739,287	23,124	15,335	....	777,746	755,451	.97	160	1,238
Rock Island	22,074	39,848	4,061	....	65,983	123,474	1.88	166	106
St. Clair	3,634,322	187,960	109,197	....	3,931,479	3,566,857	.91	157	5,113
Saline	3,712,201	36,614	71,595	....	3,820,410	4,144,308	1.08	204	4,895
Sangamon	4,733,096	255,767	148,972	....	5,137,835	5,248,253	1.02	175	6,936

[a] Bond, Calhoun, Greene, Hancock, Jefferson, McLean, Morgan, Moultrie, Putnam, Schuyler, Scott, Warren, Washington, White, Will, and Woodford.

Coal production of Illinois in 1910 and 1911, by counties, in short tons—Continued.

1911—Continued.

County.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Made into coke.	Total quantity.	Total value.	Average price per ton.	Average number of days active.	Average number of employees.
Shelby	54,939	21,902	4,774	....	81,615	$139,983	$1.72	202	197
Stark	8,460	27,033	1,800	....	37,293	63,007	1.69	235	54
Tazewell	146,000	67,274	7,509	....	220,783	293,182	1.33	228	336
Vermilion	3,159,386	172,018	53,796	....	8,385,200	3,694,799	1.09	248	3,942
Will	161,721	10,824	5,852	....	178,397	308,560	1.73	206	411
Williamson	6,137,410	195,013	195,831	85,775	6,614,029	6,888,812	1.04	170	8,527
Other counties [a] and small mines	1,060,260	232,208	64,967	....	1,357,435	2,076,171	1.53	239	2,39
Total	49,163,827	2,806,197	1,623,319	85,775	53,679,118	59,519,478	1.11	188	76,60

[a] Bond, Calhoun, Greene, Hancock, Jefferson, Johnson, McLean, Morgan, Moultrie, Putnam, Schuyler, Scott, Warren, Washington, White, and Woodford.

In the following table are shown the statistics of production of coal in Illinois, by counties, during the last five years, with increase and decrease in 1911 as compared with 1910:

Coal production of Illinois, 1907–1911, by counties, in short tons.

County.	1907	1908	1909	1910	1911	Increase (+) or decrease (−), 1911.
Bond	138,990	60,129	89,861	139,398	119,250	− 20,14
Bureau	2,010,762	1,512,971	1,612,452	973,346	1,628,688	+ 655,34
Calhoun	2,850	3,521	....	....	1,400	+ 1,40
Christian	1,368,159	1,377,166	1,395,158	1,223,295	1,222,259	− 1,03
Clinton	1,302,391	1,078,848	970,709	950,243	921,225	− 29,01
Franklin	1,306,966	2,187,383	2,316,509	1,778,768	3,555,586	+ 1,776,81
Fulton	2,113,643	2,012,415	2,388,617	1,721,527	2,133,029	+ 411,5
Gallatin	78,055	59,667	64,713	70,091	63,008	− 7,0
Greene	2,310	9,506	7,318	9,082	6,207	− 2,87
Grundy	1,327,321	1,081,442	1,114,101	600,281	776,800	+ 176,51
Hamilton	....	(*a*)	....	....	....	....
Hancock	2,034	1,406	1,085	640	230	− 41
Henry	149,721	141,624	137,060	124,243	90,722	− 33,5
Jackson	645,333	624,055	652,280	584,240	687,753	+ 103,51
Jefferson	12,000	18,675	4,800	10,000	9,500	− 5
Jersey	1,162	1,496	1,000	....	....	....
Kankakee	26,704	30,994	25,000	....	....	....
Knox	40,996	41,040	21,973	28,295	30,136	+ 1,8
La Salle	1,677,990	1,557,173	1,686,391	1,178,885	1,610,470	+ 431,5
Livingston	303,497	265,666	246,031	162,898	89,423	− 73,4
Logan	477,115	372,980	395,888	409,244	334,860	− 74,3
McDonough	32,199	17,818	16,276	26,338	8,027	− 18,3
McLean	151,146	95,854	116,412	83,982	96,517	+ 12,5
Macon	269,766	235,237	238,607	235,361	236,203	+ 8
Macoupin	4,507,270	3,894,199	4,597,775	3,854,229	4,688,212	+ 833,9
Madison	3,927,721	3,367,820	3,373,798	4,102,773	3,152,705	− 950,0
Marion	1,185,533	981,284	1,171,950	812,873	1,224,326	+ 411,4
Marshall	482,796	393,281	295,812	267,447	423,984	+ 156,5
Menard	389,918	355,309	303,948	332,557	190,477	− 142,0
Mercer	453,621	376,435	369,762	229,024	297,552	+ 68,5
Montgomery	1,289,021	1,410,978	1,780,668	1,799,720	2,395,814	+ 596,0
Morgan	5,513	3,244	1,200	1,300	1,268	−
Peoria	1,103,312	921,929	914,961	810,595	1,037,362	+ 226,7
Perry	1,784,469	1,576,891	1,423,135	1,367,771	1,272,292	− 95,4
Putnam	362,858	466,019	597,703	364,882	772,976	+ 408,0
Randolph	824,761	751,605	799,893	1,025,557	777,746	− 247,
Rock Island	52,938	50,781	46,228	66,207	65,983	− 2
St. Clair	4,511,879	3,696,017	3,471,630	5,788,567	3,931,479	− 1,857,
Saline	2,247,842	2,552,137	3,283,939	2,459,650	3,820,410	+ 1,360,7
Sangamon	5,160,042	5,015,608	5,616,357	4,449,634	5,137,835	+ 688,
Schuyler	7,553	15,269	4,573	2,427	6,138	+ 3,7
Scott	17,639	3,427	2,056	2,400	464	− 1,
Shelby	155,930	181,373	124,087	135,672	81,615	− 54,
Stark	25,897	20,351	23,159	32,582	37,293	+ 4,

[a] Included with production of Hancock County.

Coal production of Illinois, 1907–1911, by counties, in short tons—Continued.

County.	1907	1908	1909	1910	1911	Increase (+) or decrease (−), 1911.
Tazewell	235,971	206,882	208,049	155,659	220,783	+ 65,124
Vermilion	2,973,253	2,452,485	1,919,955	2,515,250	3,385,200	+ 869,950
Warren	9,139	11,687	12,304	10,275	9,044	− 1,231
Washington	29,000	72,500	31,322	22,500	25,000	+ 2,500
White	16,453	19,583	22,133	23,722	35,681	+ 11,959
Will	183,985	162,239	162,307	124,652	178,397	+ 53,745
Williamson	5,697,944	5,670,474	6,537,654	4,620,372	6,614,029	+ 1,993,657
Woodford	*a* 158,742	*b* 174,031	194,410	125,823	164,001	+ 38,178
Small mines	75,036	68,786	*c* 111,981	85,969	109,759	+ 23,790
Total	51,317,146	47,659,690	50,904,990	45,900,246	53,679,118	+ 7,778,872
Total value	$54,687,382	$49,978,247	$53,522,014	$52,405,897	$59,519,478	+$7,113,581

[a] Includes production of Wabash County.
[b] Includes production of Edgar and Moultrie counties.
[c] Includes production of Crawford and Moultrie counties.

Probably the earliest mention of coal in the United States is contained in the journal of Father Hennepin, a French missionary, who as early as 1679 reported a "cole" mine on Illinois River above Fort Crevecœur, near the site of the present city of Ottawa. Father Hennepin marked the location of the occurrence on the map which illustrates his journal. It is also probable that, outside of anthracite mining in Pennsylvania and the operations of the Richmond Basin in Virginia, Illinois holds the record for priority of production. The earliest statement that we have in regard to actual mining in Illinois is that coal was produced in Jackson County in 1810 from a point on Big Muddy River. A flatboat was loaded with coal at this place and shipped to New Orleans, but the quantity is not stated. Again, it is reported that in 1832 several boatloads were sent from the same vicinity to the same market. Another record is found stating that 150,000 bushels (or 6,000 tons) of coal were mined in 1833 in St. Clair County and hauled by wagons to St. Louis. From 1840 to 1860 the bureau of statistics of the State is without any reliable data in regard to the coal-mining industry, although some scattering statistics are found in the geologic reports published by the State government.

The production of coal in Illinois from 1833 to the close of 1911 is shown in the following table:

Production of coal in Illinois, 1833—1911, in short tons.

Year.	Quantity.	Year.	Quantity.	Year.	Quantity.	Year.	Quantity.
1833	6,000	1854	385,000	1875	4,453,178	1896	19,786,626
1834	7,500	1855	400,000	1876	5,000,000	1897	20,072,758
1835	8,000	1856	410,000	1877	5,350,000	1898	18,599,299
1836	10,000	1857	450,000	1878	5,700,000	1899	24,439,019
1837	12,500	1858	490,000	1879	5,000,000	1900	25,767,981
1838	14,000	1859	530,000	1880	6,115,377	1901	27,331,552
1839	15,038	1860	728,400	1881	6,720,000	1902	32,939,373
1840	16,967	1861	670,000	1882	9,115,653	1903	36,957,104
1841	35,000	1862	780,000	1883	12,123,456	1904	36,475,060
1842	58,000	1863	890,000	1884	12,208,075	1905	38,434,363
1843	75,000	1864	1,000,000	1885	11,834,459	1906	41,480,104
1844	120,000	1865	1,260,000	1886	11,175,241	1907	51,317,146
1845	150,000	1866	1,580,000	1887	12,423,066	1908	47,659,690
1846	165,000	1867	1,800,000	1888	14,328,181	1909	50,904,990
1847	180,000	1868	2,000,000	1889	12,104,272	1910	45,900,246
1848	200,000	1869	1,854,000	1890	15,292,420	1911	53,679,118
1849	260,000	1870	2,624,163	1891	15,660,698		
1850	300,000	1871	3,000,000	1892	17,862,276	Total.	844,012,353
1851	320,000	1872	3,360,000	1893	19,949,564		
1852	340,000	1873	3,920,000	1894	17,113,576		
1853	375,000	1874	4,203,000	1895	17,735,864		

INDIANA.

Total production in 1911, 14,201,355 short tons; spot value, $15,326,808.

As in 1910 the coal mines of Indiana gained in production by reason of the strike in the Mississippi Valley States, so in 1911 was the production in Indiana reduced because of the increased output from the other districts. At the strike call in 1910 about 60 per cent of the Indiana miners responded, but did not long remain idle, the average time lost by the 12,683 men on strike being 34 days, whereas in the Mississippi Valley States the majority of the miners were idle for nearly six months.

The benefit derived by Indiana in 1910 from the idleness in the other States was an increase of 24 per cent in production over 1909. The return to normal conditions in 1911 resulted in a decrease of 4,188,460 short tons, or 23 per cent, from 18,389,815 short tons in 1910 to 14,201,355 tons in 1911. The value decreased $5,486,851, or 26 per cent, from $20,813,659 to $15,326,808. The production in 1911 was 632,904 tons less than in 1909, but the value of the 1911 output exceeded that of 1909 by $172,127. The average price per ton which jumped from $1.02 in 1909 to $1.13 in 1910, declined to $1.08 in 1911.

The principal increases in 1910 were in Greene and Sullivan counties, which have been the scenes of notable activity during the last few years and are now two of the principal coal-producing counties. Those two counties were second and third in the decrease of production in 1911, but the chief loss was sustained by Vigo County, whose output decreased 1,388,447 tons, or 33 per cent. Greene County's production fell off 875,636 tons, and Sullivan's 774,147 tons. Decreased tonnage was reported from every county but three, Owen Spencer, and Vermilion, and the aggregate increase in those three counties was less than 60,000 tons.

Of the total production of 14,201,355 short tons in 1911, 7,049,75 tons, or nearly 50 per cent, were undercut by machines. In 191 when the production amounted to 18,389,815 tons, the quantit mined by machines was 8,986,495 tons, the proportion of the machine mined product to the total being a fraction of 1 per cent in favor o 1911. The number of machines reported in 1911 was 667, agains 645 in 1910, an increase of 22. Machines of the chain-breast typ are in the majority, there being 426, or more than two-thirds of th total number in 1911, of that type. One-fourth of the total numbe or 166, were pick machines, 30 were long-wall, and 45 were short-wa or "continuous cutters." Outside of the machine-mined tonnage the production in 1911 from mines reporting the mining methods i practice was 6,489,406 short tons, of which 1,098,903, or 16.9 pe cent, were mined by hand, and 5,390,503 tons, or 83.1 per cent, wer shot off the solid. The quantity of coal shot off the solid in 191 was nearly five times that mined by hand, and was equivalent to per cent of the total production of the State.

The time lost by strikes in the mines of Indiana in 1911 was abou one-third of that lost in 1910. In 1910 there were 12,638 men o strike during an average of 34 days; in 1911 there were 4,577 me idle for an average of 32 days. As the time lost in 1911 was, how ever, only 4 per cent of the total time made, the idleness did n affect the production. The shutdowns for lack of orders were more influence on the production, the average number of workin days being 47 days fewer than in 1910, and there was, of course, a corresponding decrease in the tonnage won per man employed. In 1910 there were 21,878 men employed in the coal mines of Indiana for an average of 229 days. They produced an average of 841 tons each for the year, and 3.67 tons on each working day. In 1911 there were 21,182 men employed an average of 182 days, and the average production per man was 670 tons for the year and 3.68 tons per day.

The death rate due to accidents in the coal mines of Indiana in 1911, according to reports to the United States Bureau of Mines, was 2.17, and the number of tons mined for each life lost was 308,725. There were 46 men killed—40 underground, 3 in shafts, and 3 on the surface. Of the deaths underground nearly one-half (19 in all) were due to falls of roof or coal, 4 were due to explosions of gas or dust, 10 to powder explosions, 4 to haulage accidents, and 3 to miscellaneous causes.

The statistics of coal production in Indiana in 1910 and 1911, by counties, with the distribution of the product for consumption, are shown in the following table:

Coal production of Indiana in 1910 and 1911, by counties, in short tons.

1910.

County.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Total quantity.	Total value.	Average price per ton.	Average number of days active.	Average number of employees.
Clay	919,375	36,948	23,693	980,016	$1,364,759	$1.39	220	1,727
Daviess	56,680	27,680	3,014	87,374	120,564	1.38	205	228
Dubois and Martin		6,950	1,340	8,290	11,260	1.36	231	14
Fountain and Warren		8,322	100	8,422	16,524	1.96	210	24
Gibson	269,215	24,355	3,183	296,753	336,346	1.13	252	781
Greene	3,313,466	45,941	79,595	3,439,002	3,841,530	1.12	241	3,570
Knox	970,770	15,884	17,255	1,003,909	1,005,955	1.00	233	870
Owen	1,600	8,950	140	10,690	15,780	1.48	125	31
Parke	712,078	28,481	23,556	764,115	1,054,914	1.38	214	1,265
Perry	600	25,415	302	26,317	34,826	1.32	211	47
Pike	653,166	37,044	7,175	697,385	802,571	1.15	225	918
Spencer	989	8,105	2	9,096	12,927	1.42	165	22
Sullivan	3,909,097	39,494	87,343	4,035,934	4,496,172	1.11	223	4,202
Vanderburg	120,114	261,340	16,839	398,293	418,902	1.05	236	426
Vermilion	1,585,821	25,552	24,250	1,635,623	1,707,723	1.05	214	1,767
Vigo	3,996,910	95,568	89,321	4,181,799	4,733,292	1.13	236	5,185
Warrick	716,253	37,608	14,845	768,706	788,504	1.03	222	801
Small mines		38,091		38,091	51,110	1.34		
Total	17,226,134	771,728	391,953	18,389,815	20,813,659	1.13	229	21,878
1911.								
Clay	721,263	26,533	31,576	779,372	$986,457	$1.28	173	1,573
Daviess	57,600	17,506	4,360	79,466	104,381	1.31	187	240
Dubois and Martin		4,119		4,119	5,686	1.38	143	14
Fountain and Warren		5,625		5,625	11,660	2.11	240	16
Gibson	223,618	18,560	4,950	247,128	270,008	1.09	201	321
Greene	2,457,831	45,143	60,392	2,563,366	2,739,788	1.06	200	3,191
Knox	826,853	25,830	26,640	879,323	872,714	1.00	171	835
Owen	20,474	2,219		22,693	40,216	1.77	154	90
Parke	471,939	19,569	30,059	521,567	641,293	1.23	164	1,116
Perry		16,378	305	16,683	22,253	1.33	226	51
Pike	428,815	29,964	8,844	467,623	513,954	1.10	153	842
Spencer	2,455	7,084	12	9,551	13,167	1.38	198	31
Sullivan	3,147,202	41,280	73,305	3,261,787	3,430,587	1.05	187	4,505
Vanderburg	78,630	190,602	9,877	279,109	357,963	1.25	223	488
Vermilion	1,588,121	24,647	60,853	1,673,621	1,691,166	1.00	177	2,162
Vigo	2,608,681	101,522	83,149	2,793,352	2,990,086	1.07	179	4,833
Warrick	501,472	29,559	14,101	545,132	559,179	1.03	166	874
Small mines		51,838		51,838	76,250	1.47		
Total	13,134,954	657,978	408,423	14,201,355	15,326,808	1.08	182	21,182

Coal production of Indiana, 1907–1911, by counties, in short tons.

County.	1907	1908	1909	1910	1911	Increase (+) or decrease (−), 1911.
Clay	1,266,507	863,649	958,732	980,016	779,372	− 200,644
Daviess	120,996	77,034	73,877	87,374	79,466	− 7,908
Dubois	[a] 8,460	[a] 12,320	[a] 35,404	[a] 8,290	[a] 4,119	− 4,171
Fountain	[b] 41,270	....	5,520	3,300	1,700	− 1,600
Gibson	207,472	188,500	232,599	296,753	247,128	− 49,625
Greene	2,773,944	2,361,404	2,612,686	3,439,002	2,563,366	− 875,636
Knox	374,099	428,821	642,727	1,003,909	879,323	− 124,586
Owen	....	....	15,904	10,690	22,693	+ 12,003
Parke	655,312	644,062	730,082	764,115	521,567	− 242,548
Perry	17,965	10,601	15,603	26,317	16,683	− 9,634
Pike	516,418	460,180	447,122	697,385	467,623	− 229,762
Spencer	25,916	13,206	11,118	9,096	9,551	+ 455
Sullivan	2,897,840	2,602,543	3,227,515	4,035,934	3,261,787	− 774,147
Vanderburg	317,371	263,171	271,644	398,293	279,109	− 119,184
Vermilion	1,442,103	1,142,802	1,443,099	1,635,623	1,673,621	+ 37,998
Vigo	2,724,743	2,735,399	3,562,534	4,181,799	2,793,352	−1,388,447
Warren	....	4,800	7,130	5,122	3,925	− 1,197
Warrick	568,522	482,613	488,194	768,706	545,132	− 223,574
Small mines	26,775	23,785	52,769	38,091	51,838	+ 13,747
Total	13,985,713	12,314,890	14,834,259	18,389,815	14,201,355	− 4,188,460
Total value	$15,114,300	$13,084,297	$15,154,681	$20,813,659	$15,326,808	−$5,486,851

[a] Includes Martin County.

[b] Includes Warren County.

The United States census for 1840 reported a production of coa in Indiana for that year which amounted to 9,682 tons. The censu for 1850 did not include any investigation of the mining industry and the next official statistics cover the year 1860, when 101,281 ton were produced in the State. Ten years later the census of 187 reported a production of 437,870 short tons. In 1880 the productio had grown to 1,454,327 short tons, and in 1890 it amounted t 3,305,737 short tons. In the closing year of the last century th production had nearly doubled again, amounting to 6,484,086 shor tons, and that output nearly trebled in 1910.

The statistics of coal production in Indiana from 1840 to the clos of 1911 are given in the following table, the years for which no offici statistics are available having been estimated from the best informa tion obtainable:

Production of coal in Indiana from 1840 to 1911, in short tons.

Year.	Quantity.	Year.	Quantity.	Year.	Quantity.	Year.	Quantit
1840	9,682	1859	95,000	1878	1,000,000	1897	4,151,
1841	10,000	1860	101,280	1879	1,196,490	1898	4,920,
1842	18,000	1861	128,000	1880	1,454,327	1899	6,006,
1843	25,000	1862	150,000	1881	1,984,120	1900	6,484,
1844	30,000	1863	200,000	1882	1,976,470	1901	6,918,
1845	35,000	1864	250,000	1883	2,560,000	1902	9,446,
1846	40,000	1865	280,000	1884	2,260,000	1903	10,794,
1847	45,000	1866	320,000	1885	2,375,000	1904	10,842,
1848	50,000	1867	350,000	1886	3,000,000	1905	11,895,
1849	56,000	1868	375,000	1887	3,217,711	1906	12,092,
1850	60,000	1869	400,000	1888	3,140,979	1907	13,985,
1851	60,000	1870	437,870	1889	2,845,057	1908	12,314,
1852	75,000	1871	600,000	1890	3,305,737	1909	14,834,
1853	75,000	1872	896,000	1891	2,973,474	1910	18,389,
1854	80,000	1873	1,000,000	1892	3,345,174	1911	14,201,
1855	80,000	1874	812,000	1893	3,791,851		
1856	85,000	1875	800,000	1894	3,423,921	Total.	219,180,
1857	85,000	1876	950,000	1895	3,995,892		
1858	87,000	1877	1,000,000	1896	3,905,779		

IOWA.

Total production in 1911, 7,331,648 short tons; spot value, $12,663,507.

The strike of 1910, which stopped production in most of the mines in the States of the Middle West for the greater part of six months, lasted in Iowa for only six weeks, and the production in that State increased over that of the preceding year instead of decreasing. In 1911 conditions were reversed, so far as production is concerned, for whereas in neighboring States the output increased, that of Iowa decreased. Compared with 1910, the production of Iowa in 1911 showed a decrease of 596,472 short tons, or 7.5 per cent, in quantity and $1,240,406, or 8.92 per cent, in value. Prices were fairly well maintained and the average for 1911 was only 2 cents less than that for 1910, which was the highest recorded in recent years. Iowa is not one of the more important manufacturing States, its population depending chiefly upon agriculture, and the markets for its coal, outside of that taken by the railroads, are largely in rural communities and cities of moderate size. Most of the coal production is from mines with capacities ranging from 50,000 to 150,000 tons, there being but three operations in the State which produce over 200,000 tons annually. The growth of the coal-mining industry is fairly indicative of the increase and prosperity of the population. It has been relatively steady and without violent fluctuations.

Coal was mined in 21 counties in 1911, against 22 in 1910. All but 7 counties showed decreased production in 1911, the 2 counties suffering the largest decreases being Appanoose (309,173 tons) and Polk (246,254 tons). The largest increase was made in Dallas County, which showed a gain of 130,503 tons, or more than 50 per cent.

The number of men employed in the mines of Iowa in 1911 was 16,599, who worked an average of 203 days and produced an average of 441.7 tons. The average daily production was 2.18 tons. In 1910, when 16,666 men were employed for an average of 218 days, the average production per man was 476 tons annually and 2.18 tons daily (the same daily output as in 1911).

There were 12 instances of labor trouble in Iowa during 1911. In most cases it was quickly and easily adjusted. The longest period of idleness was 60 days and affected 265 men. In another case 76 men were idle 53 days. The total number of men on strike during the year was 1,622, and they lost an average of 20 days each. The total time lost by reason of strikes was about 0.9 per cent of the time made and did not affect the total production.

In Iowa, as in the other States of the interior province, shooting coal off the solid is practiced to an unfortunate degree. Out of a total of 7,331,648 short tons in 1911, the methods employed in mining were reported by properties whose aggregate production was 6,171,995 short tons, or nearly 85 per cent of the total output of the State. Of the 6,171,995 tons for which the mining methods were reported, the quantity shot off the solid was 5,017,108 short tons, or 81.3 per cent. The quantity mined by hand was 1,111,924 short tons, or 18 per cent. The quantity of coal mined by machines in Iowa is relatively insignificant, amounting in 1911 to 42,963 short tons, or to 0.59 per cent of the total output of the State, and to 0.7 per cent of the quantity of coal for which the mining methods employed were reported.

Iowa's death roll from coal-mining accidents in 1911, according to reports to the United States Bureau of Mines, was 40, of which 36 were underground and 4 in shafts. Falls of roof and coal caused 22 deaths, nearly half the total number, and mine cars and haulage motors killed 12. The death rate for the year was 2.45 per thousand employees, and there were 183,291 tons mined for each life lost.

The statistics of coal production in Iowa in 1910 and 1911, by counties, with the distribution of the product for consumption, are shown in the following table:

Coal production of Iowa in 1910 and 1911, by counties, in short tons.

1910.

County.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Total quantity.	Total value.	Average price per ton.	Average number of days active.	Average number of employees.
Adams	100	12,615	30	12,745	$34,706	$2.72	175	42
Appanoose	1,344,843	54,497	14,556	1,413,896	2,813,578	1.99	200	4,578
Boone	237,479	27,198	11,205	275,882	550,178	1.99	222	762
Dallas	245,255	5,510	4,320	255,085	447,817	1.76	210	530
Greene	600	9,300	250	10,150	26,175	2.58	183	47
Guthrie	....	17,324	....	17,324	53,665	3.10	185	27
Jasper	334,966	14,087	10	349,063	740,132	2.12	228	718
Keokuk	800	11,841	500	13,141	25,443	1.94	219	30
Mahaska	787,714	36,365	24,120	848,199	1,131,408	1.33	229	1,583
Marion	190,520	21,766	2,995	215,281	348,992	1.62	198	599
Monroe	2,079,205	48,567	56,258	2,184,030	3,506,140	1.61	238	3,401
Polk	1,536,133	193,406	48,725	1,778,264	3,140,598	1.77	217	3,022
Taylor	5,622	4,092	35	9,749	24,233	2.49	154	47
Van Buren	5,000	5,152	132	10,284	23,960	2.33	215	21
Wapello	234,963	44,298	4,239	283,500	498,210	1.76	236	599
Wayne	125,926	9,453	60	135,439	280,100	2.07	230	40
Webster	39,913	8,707	1,353	49,973	111,720	2.24	169	18
Other counties [a] and small mines	....	64,693	1,422	66,115	146,858	2.22	193	7
Total	7,169,039	588,871	170,210	7,928,120	13,903,913	1.75	218	16,66

1911.

County.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Total quantity.	Total value.	Average price per ton.	Average number of days active.	Average number of employees.
Adams	160	7,272	40	7,472	$18,779	$2.51	120	5
Appanoose	1,023,405	55,051	26,267	1,104,723	2,102,485	1.90	163	4,06
Boone	174,932	26,388	13,120	214,440	413,548	1.93	206	65
Dallas	371,794	7,204	6,590	385,588	731,805	1.90	257	70
Greene	800	11,000	....	11,800	30,400	2.58	160	4
Guthrie	....	10,390	....	10,390	29,570	2.84	142	5
Jasper	277,795	14,587	45	292,427	672,532	2.30	219	64
Keokuk	....	11,697	815	12,512	23,978	1.92	188	2
Mahaska	733,178	22,152	21,859	777,189	1,200,117	1.54	213	1,4
Marion	149,803	15,446	6,080	171,329	265,303	1.55	225	3
Monroe	2,140,265	55,181	63,793	2,259,239	3,402,743	1.51	217	4,2
Polk	1,302,029	173,288	56,693	1,532,010	2,729,625	1.78	217	2,9
Taylor	4,565	5,385	....	9,950	22,979	2.32	135	
Van Buren	6,000	2,651	5	8,656	20,340	2.35	208	
Wapello	268,784	38,690	4,858	312,332	523,535	1.68	226	5
Wayne	103,640	11,442	1,300	116,382	234,761	2.00	203	3
Webster	37,749	6,425	1,852	46,026	101,949	2.13	173	1
Other counties [b] and small mines	....	58,270	913	59,183	139,058	2.35	151	1
Total	6,594,899	532,519	204,230	7,331,648	12,663,507	1.73	203	16,5

[a] Jefferson, Lucas, Page, Scott, and Warren.

[b] Jefferson, Lucas, Page, and Warren.

The production by counties during the last five years, with increas and decrease in 1911 as compared with 1910, is shown in the followi table:

Coal production of Iowa, 1907–1911, by counties, in short tons.

County.	1907	1908	1909	1910	1911	Increase (+) or decrease (−), 1911.
Adams	14,343	17,492	13,194	12,745	7,472	− 5,273
Appanoose	1,123,409	1,144,405	1,236,009	1,413,896	1,104,723	− 309,173
Boone	208,150	237,498	275,711	275,882	214,440	− 61,442
Dallas	70,042	174,585	244,219	255,085	385,588	+ 130,503
Davis	1,300	3,700				
Greene	16,289	15,431	9,700	10,150	11,800	+ 1,650
Guthrie			6,730	17,324	10,390	− 6,934
Jasper	397,297	393,516	323,092	349,063	292,427	− 56,636
Jefferson	4,000	3,500	6,255	7,530	5,129	− 2,401
Keokuk	27,716	18,301	14,430	13,141	12,512	− 629
Lucas	105,536	8,739	9,326	11,233	13,337	+ 2,104
Mahaska	757,778	807,515	925,438	848,199	777,189	− 71,010
Marion	346,999	294,607	329,353	215,281	171,329	− 43,952
Monroe	2,476,021	1,967,337	2,025,559	2,184,030	2,259,239	+ 75,209
Page	14,338	11,364	16,134	10,550	12,396	+ 1,846
Polk	1,460,203	1,616,895	1,788,129	1,778,264	1,532,010	− 246,254
Scott	1,047	1,248	8,400	400		− 400
Taylor	19,692	18,003	13,536	9,749	9,950	+ 201
Van Buren	15,374	15,362	15,955	10,284	8,656	− 1,628
Wapello	258,651	189,506	261,520	283,500	312,332	+ 28,832
Warren	5,054	6,820	16,201	1,992	1,500	− 492
Wayne	146,901	127,409	128,004	135,439	116,382	− 19,057
Webster	80,275	62,768	66,584	49,973	46,026	− 3,947
Other counties and small mines	23,907	25,309	24,283	34,410	[a] 26,821	− 7,589
Total	7,574,322	7,161,310	7,757,762	7,928,120	7,331,648	− 596,472
Total value	$12,258,012	$11,706,402	$12,793,628	$13,903,913	$12,663,507	−$1,240,406

[a] Small mines only..

Iowa probably ranks second among the States west of Mississippi River in order of priority as a coal producer. At the time of taking the United States census for 1840 Iowa and Missouri were the only States west of the Mississippi in which any coal production was reported. Missouri, however, was credited with an output of nearly 10,000 tons, and Iowa's production was given at 400 tons. It is probable, therefore, that the first mine opened in Missouri antedated Iowa's initial production. The production of coal in Iowa since 1840 will be found in the following table, estimates being given for years for which no official figures are available:

Production of coal in Iowa, 1840 to 1911, in short tons.

Year.	Quantity.	Year.	Quantity.	Year.	Quantity.	Year.	Quantity.
1840	400	1858	37,500	1876	1,250,000	1894	3,967,253
1841	500	1859	42,000	1877	1,300,000	1895	4,156,074
1842	750	1860	41,920	1878	1,350,000	1896	3,954,028
1843	1,000	1861	50,000	1879	1,400,000	1897	4,611,865
1844	2,500	1862	53,000	1880	1,461,116	1898	4,618,842
1845	5,000	1863	57,000	1881	1,960,000	1899	5,177,479
1846	6,500	1864	63,000	1882	3,920,000	1900	5,202,939
1847	8,000	1865	69,574	1883	4,457,540	1901	5,617,499
1848	10,000	1866	99,320	1884	4,370,566	1902	5,904,766
1849	12,500	1867	150,000	1885	4,012,575	1903	6,419,811
1850	15,000	1868	241,453	1886	4,315,779	1904	6,519,933
1851	18,000	1869	295,105	1887	4,473,828	1905	6,798,609
1852	20,000	1870	263,487	1888	4,952,440	1906	7,266,224
1853	23,000	1871	300,000	1889	4,095,358	1907	7,574,322
1854	25,000	1872	336,000	1890	4,021,739	1908	7,161,310
1855	28,000	1873	392,000	1891	3,825,495	1909	7,757,762
1856	30,000	1874	799,936	1892	3,918,491	1910	7,928,120
1857	33,000	1875	1,231,547	1893	3,972,229	1911	7,331,648
						Total.	171,787,632

KANSAS.

Total production in 1911, 6,254,228 short tons; spot value, $9,645,572.

In proportion to its production Kansas suffered more than any other State in the Mississippi Valley region from the labor troubles in 1910. In Illinois, the storm center of the strike, the production in 1910 was 9.83 per cent less than in 1909; Missouri's production fell off 20.6 per cent; Oklahoma's decreased 15.2 per cent, and Arkansas showed a decrease of 19.8 per cent. The production of coal in Kansas decreased 29.56 per cent, the quantity of decrease (2,065,027 tons) being more than the total production of Arkansas in 1910 and more than 75 per cent of that of Oklahoma. From the lowest record of the last decade, 4,921,451 short tons, valued at $7,914,709, in 1910, the production in 1911 increased to 6,254,228 tons, valued at $9,645,572. The increase amounted to 1,322,777 short tons, or 27.08 per cent, in quantity and $1,730,863, or 21.87 per cent, in value, but was not enough to bring the total up to normal, as the production in 1911 was nearly 50,000 tons less than the average production of the preceding five years, which included the greatly reduced tonnage of 1910. The average price per ton declined from $1.61 in 1910, when values were naturally somewhat augmented, to $1.54 in 1911. In 1909 when conditions were more comparable with those of 1911, the average price per ton was $1.44, or 10 cents per ton less than in 1911. The difference in the value of the production in 1911 taken at the prices of 1909 and 1911 is $639,484. The mean average price of Kansas coal for seven years, from 1904 to 1910, inclusive, was $1.50, compared with which the average for 1911 shows an advance of 4 cents a ton, which on the tonnage of 1911 would amount to $250,169.

In 1910 there were 12,870 men employed in the coal mines of Kansas, and of these 10,346, or 80 per cent, were idle during the 6-months' strike; the average number of working days was 148; the average production per man was 382 tons per year, and 2.58 tons per working day. In 1911 there were 11,625 men employed for an average of 189 days; the average production per man was 538 tons per year, and 2.85 tons per day. Ninety per cent of the total production of Kansas is from the two counties of Cherokee and Crawford in the extreme southeastern corner of the State. The increase in those two counties in 1911 was a little more than the total increase in the State, decreases in Osage and Cloud counties and in the small-mine production offsetting in part the increases in Cherokee and Crawford counties.

Probably three-fourths of the production of Leavenworth County (281,549 short tons in 1911) should be credited to Platte County Mo., as the workings at Leavenworth, Kans., extend under Missour River into the State of Missouri and most of the tonnage comes from the portion of the coal bed that underlies the latter State. It has been customary, however, to credit the production to the State in which the openings and tipples are located, and all the production from these mines is credited to Leavenworth County, Kans. If the por tion mined in Missouri were deducted from the Kansas production Cherokee and Crawford counties would furnish all but about 2 per cen of the State's total. The larger part of the output of Kansas, and particularly that from Cherokee and Crawford counties, is used fo locomotive fuel, and some of the larger mines are operated by th fuel departments of the railroads or by companies affiliated with the transportation interests. In such cases none of the product is marketed as commercial coal.

What has been said in the discussion of coal mining in the other States of the Mississippi Valley region with regard to shooting the coal off the solid applies with equal force to Kansas. Out of a total production of 6,254,228 short tons in 1911 the methods employed in the Kansas coal mines were reported by operators whose total output amounted to 5,380,732 short tons, or 86 per cent of the total output of the State. The quantity of coal shot off the solid in 1911 was 4,857,714 short tons, or 90.3 per cent of the total quantity for which the mining methods were reported. Only 7.9 per cent, or 422,574 tons, was mined by hand, and only 1.8 per cent, or 100,444 tons, was mined by machines. The machine-mined production, however, showed a considerable percentage of gain in 1911 over 1910, when 34,240 short tons were reported as having been mined by machines. The machine-mined tonnage in 1911 was nearly three times that of the preceding year. Most of the mines of Kansas work under agreements with the United Mine Workers of America, and the 8-hour working day prevails. Labor difficulties throughout the State were of small consequence in 1911.

Reports to the United States Bureau of Mines show that there were 42 men killed in and about the coal mines of Kansas in 1911. Forty of these were underground, and one-half of the underground fatalities were due to falls of roof and coal. Explosions of gas and dust killed 10 and explosions of powder killed 3. Seven deaths were due to miscellaneous causes. The death rate was 3.61, and the number of tons mined for each life lost was 148,910.

The statistics of the production of coal in Kansas in 1910 and 1911, with the distribution of the product for consumption, are shown in the following table:

Coal production of Kansas in 1910 and 1911, by counties, in short tons.

1910.

County.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Made into coke.	Total quantity.	Total value.	Average price per ton.	Average number of days active.	Average number of employees.
Cherokee	1,407,690	33,936	35,899	....	1,477,525	$2,232,818	$1.51	132	3,606
Crawford	2,858,040	63,311	65,060	....	2,986,411	4,578,266	1.53	148	7,458
Leavenworth	184,847	48,382	41,557	591	275,377	648,127	2.35	185	1,066
Linn	17,225	6,103	970	....	24,298	46,902	1.93	146	66
Osage	104,929	11,669	171	....	116,769	322,924	2.77	175	669
Other counties[a] and small mines	2,000	39,071	....	....	41,071	85,672	....	....	5
Total	4,574,731	202,472	143,657	591	4,921,451	7,914,709	1.61	148	12,870

1911.

County.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Made into coke.	Total quantity.	Total value.	Average price per ton.	Average number of days active.	Average number of employees.
Cherokee	1,951,284	34,099	50,669	....	2,036,052	$2,956,171	$1.45	182	3,510
Crawford	3,651,806	33,301	93,135	....	3,778,242	5,670,934	1.50	194	6,464
Leavenworth	225,994	21,141	33,839	575	281,549	650,017	2.31	192	936
Linn	18,367	7,879	1,120	....	27,366	48,704	1.78	177	82
Osage	82,211	22,064	204	....	104,479	261,901	2.51	174	610
Other counties[b] and small mines	2,400	24,140	....	....	26,540	57,845	2.18	113	23
Total	5,932,062	142,624	178,967	575	6,254,228	9,645,572	1.54	189	11,625

[a] Cloud and Franklin.

[b] Atchison, Franklin, and Neosho.

The statistics of production, by counties, during the last five years, with increase and decrease in 1911 as compared with 1910, are shown in the following table:

Coal production of Kansas, 1907-1911, in short tons.

County.	1907	1908	1909	1910	1911	Increase (+) or decrease (−), 1911.
Atchison			(a)		(a)	
Cherokee	2,325,744	1,826,081	2,201,947	1,477,525	2,036,052	+ 558,527
Cloud	6,512	4,500	800	800		− 800
Crawford	4,380,628	3,917,818	4,328,012	2,986,411	3,778,242	+ 791,831
Franklin	3,560	1,604	3,160	2,000	2,400	+ 400
Leavenworth	424,338	348,117	321,132	275,377	281,549	+ 6,172
Linn	27,488	11,581	8,544	24,298	27,366	+ 3,068
Osage	138,049	126,448	100,197	116,769	104,479	− 12,290
Other counties and small mines	16,130	9,359	22,686	38,271	24,140	− 14,131
Total	7,322,449	6,245,508	6,986,478	4,921,451	6,254,228	+ 1,332,777
Total value	$11,159,698	$9,292,222	$10,083,384	$7,914,709	$9,645,572	+$1,730,863

[a] Included in other counties.

The earliest record of coal production in Kansas shows that the State produced in 1869 a total of 36,891 tons. From 1870 to 1880 the production has been estimated from the best information obtainable, and since 1882 it has been collected by the statistical division of the United States Geological Survey, as shown in the following table, giving the annual production of coal in Kansas from 1869 to the close of 1911:

Production of coal in Kansas, 1869 to 1911, in short tons.

Year.	Quantity.	Year.	Quantity.	Year.	Quantity.	Year.	Quantity.
1869	36,891	1880	771,442	1891	2,716,705	1902	5,266,065
1870	32,938	1881	840,000	1892	3,007,276	1003	5,839,976
1871	41,000	1882	750,000	1893	2,652,546	1904	6,333,307
1872	44,800	1883	900,000	1894	3,388,251	1905	6,423,979
1873	56,000	1884	1,100,000	1895	2,926,870	1906	6,024,775
1874	85,000	1885	1,212,057	1896	2,884,801	1907	7,322,449
1875	150,000	1886	1,400,000	1897	3,054,012	1908	6,245,508
1876	225,000	1887	1,596,879	1898	3,406,555	1909	6,986,478
1877	300,000	1888	1,850,000	1899	3,852,267	1910	4,921,451
1878	375,000	1889	2,221,043	1900	4,467,870	1911	6,254,228
1879	460,000	1890	2,259,922	1901	4,900,528		
						Total	115,583,869

KENTUCKY.

Total production in 1911, 13,706,839 short tons; spot value, $13,617,217.

In 1910 Kentucky more than any other State except Virginia profited by the six months of idleness in the neighboring States to the north and west. The production of Kentucky increased from 10,697,384 short tons in 1909 to 14,623,319 tons in 1910, a gain of 3,925,935 tons, or 36.7 per cent. Most of this gain was in the western counties of Kentucky, which are nearer to the markets affected by the strike than the counties in the eastern part of the State. With no serious interruptions to operations in the other States in 1911 a decrease in the production from Kentucky was to have been expected, but the returns for the year show a much smaller decrease than the increase of the preceding year and also less in proportion than that shown in most of the Appalachian or other States whose output of coal in 1910 had been stimulated by the strike in the Middle West. As the increase in 1910 was principally in the western counties of Kentucky, so in 1911 the decrease was confined to that portion of the State. In fact, the decrease in the western counties was more than the total decrease in the State, for recent developments in the eastern counties, notably in Floyd, Johnson, Knox, and Pike counties, resulted in gains over the production of 1910 that largely offset the losses in the western counties. The decreases in the western counties amounted altogether to 1,232,558 short tons, a little less than half of the total increases made in the preceding year, and were shown in the production of every county but two. The increases in Floyd, Johnson, Knox, and Pike counties amounted to nearly 670,000 tons, and the total increase in the eastern countries was 316,078 tons, reducing the total decrease in the State to 916,480 short tons, or 6.27 per cent. The principal decrease in the eastern district was in the production of Bell County (272,319 tons), notwithstanding which the tonnage of Bell County in 1911 exceeded that of any other year preceding 1910 by over 200,000 tons.

Altogether 1911 may be considered as generally satisfactory to the coal-mining industry of Kentucky, for although the production was more than 900,000 tons less than in 1910, the decrease in value was less in proportion, being 5.47 per cent, as compared with 6.27 per cent, and in both production and value there was a substantial increase over any year prior to 1910. Compared with 1907, when the previous maximum tonnage was recorded, the production in 1911 showed an increase of nearly 3,000,000 tons in quantity and of over $2,200,000 in value.

According to the returns to the Survey, there were more men employed in the coal mines of Kentucky in 1911 than in 1910, but there was a decided reduction in the number of working days. In 1910 there were 20,316 men employed for an average of 221 days; in 1911 there were 21,821 men employed for an average of 191 days. The average production per man in 1911 was 628 tons for the year and 3.3 tons for each working day, as compared with 720 tons for the year and 3.26 tons for each working day in 1910.

The purchase in 1910, by the Consolidation Coal Co., of Baltimore, Md., of 100,000 acres of coking-coal lands in the Elkhorn district of eastern Kentucky, embracing portions of Pike and Letcher counties, and smaller sections of Floyd and Knott counties, and active developments and railroad construction in Knox and Harlan counties, have given unwonted impetus to the coal-mining industry in the eastern part of Kentucky. The results are exhibited in the statistics for 1911 and will show even more substantial gains in the near future. The new railroad construction consists of extensions of the Chesapeake & Ohio and the Louisville & Nashville railroads into the Elkhorn district, a new line, the Wasioto & Black Mountain Railroad into Harlan County, and resumption of work on the Cumberland Railroad into Knox County.

Kentucky is one of the leading States in the mining of coal by the use of machines, and ranks next to Ohio in the percentage of machine-mined tonnage to the total production. In 1911 9,002,288 short tons, or 65.7 per cent of the total production, were mined by machines, compared with 9,362,851 tons, or 64 per cent of the total in 1910.

The proportion of Kentucky's coal shot off the solid is much less than in the neighboring States where the use of mining machinery has not been so highly developed. The total quantity reported as shot off the solid in 1911 was 2,224,147 short tons, or 16.2 per cent of the total, and the quantity mined by hand was 1,766,648 tons, or 12.9 per cent. As no mining methods were reported in 1911 by Kentucky operators whose output was only 713,756 short tons, or 5.2 per cent of the total, the figures given showing the general mining practice may be considered representative of the industry as a whole. The number of mining machines employed in the coal mines of Kentucky in 1911 was 977, against 899 in 1910. Of the 977 machines in use in 1911, 544 were punchers, 309 chain-breast, 72 long-wall, and 52 short-wall or continuous cutters.

Of the 21,821 men employed in the coal mines of Kentucky during 1911, 10,189, representing 148 mines, worked 10 hours per day; 46 mines, employing 4,789 men, observed the 9-hour day; 6,103 men, the number employed in 69 mines, worked 8 hours daily; and the remaining number of mine workers (740) worked during days of varying length, or represented operators who failed to report that item of their coal production.

Statistics compiled by the United States Bureau of Mines show that there were 45 men killed in the coal mines of Kentucky as compared with 84 in 1910. The death rate per thousand was reduced from 4.13 to 2.06 and the tonnage for each fatality was increased from 174,087 to 304,596. Falls of roof were responsible for 27 deaths, more than half the total number; explosions of gas and dust killed 1 and haulage-way accidents 3.

The statistics of production in 1910 and 19 1, with the distribution of the product for consumption, are shown in the following table:

Coal production of Kentucky, 1910 and 1911, by counties, in short tons.

1910.

County.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Made into coke.	Total quantity.	Total value.	Average price per ton.	Average number of days active.	Average number of employees.
Bell	2,000,940	19,618	29,929	619	2,051,106	$2,206,636	$1.08	215	3,197
Boyd	95,071	4,650	3,330		103,051	86,921	.84	219	211
Carter	61,932	5,162	306		67,400	60,203	.89	188	116
Christian	33,388	1,364	2,384		37,136	41,007	1.10	204	99
Daviess	5,940	66,781	1,065		73,786	77,726	1.05	230	106
Floyd	134,565	895	1,870		137,330	127,628	.93	211	213
Henderson	172,932	61,532	6,817		241,281	239,332	.99	226	342
Hopkins	2,302,187	69,301	94,972	88,160	2,554,620	2,202,299	.86	256	2,595
Johnson	446,331	12,917	9,361		468,609	572,017	1.22	228	960
Knox	630,134	9,048	15,296		654,478	672,499	1.03	213	1,042
Laurel	253,955	12,840	8,429		275,224	288,515	1.05	163	713
Lawrence	97,677	1,389	1,829		100,895	89,258	.88	212	243
Lee	66,276	982	435		67,693	93,424	1.38	180	157
McLean	194,795	9,114	2,092		206,001	188,488	.91	230	255
Morgan	64,880	5,062	119		70,061	165,330	2.36	234	174
Muhlenberg	2,670,178	24,353	43,896		2,738,427	2,503,371	.91	212	3,360
Ohio	775,811	18,849	24,737		819,397	746,611	.91	210	1,290
Pike	934,219	5,937	12,725	724	953,605	869,501	.91	227	1,094
Pulaski	79,855	3,213	2,150		85,218	103,443	1.21	197	219
Union	511,143	41,240	30,907	7,088	590,378	538,888	.91	229	661
Webster	968,057	35,562	22,569		1,026,188	902,584	.88	232	1,087
Whitley	1,135,542	15,882	16,513		1,167,937	1,443,512	1.24	222	2,096
Other counties [a]	29,202	15,187	1,000		45,389	63,353	1.40	190	86
Small mines		88,109			88,109	123,341	1.40		
Total	13,665,010	528,987	332,731	96,591	14,623,319	14,405,887	.99	221	20,316

[a] Breathitt, Butler, Crittenden, Greenup, Hancock, Harlan, Leslie, Rockcastle, and Wayne.

Coal production of Kentucky, 1910 and 1911, by counties, in short tons—Continued.

1911.

County.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Made into coke.	Total quantity.	Total value.	Average price per ton.	Average number of days active.	Average number of employees.
Bell	1,736,851	23,311	18,625	....	1,778,787	$1,920,714	$1.08	214	3,880
Boyd	107,932	163	1,160	....	109,255	92,447	.85	191	168
Carter	29,160	9,450	396	....	39,006	34,565	.89	163	105
Christian	30,568	450	1,400	....	32,418	36,072	1.11	141	128
Daviess	10,640	65,136	2,359	....	78,135	77,671	.99	252	133
Floyd	244,430	2,040	4,413	....	250,883	249,532	.99	159	422
Harlan	15,230	2,180	250	200	17,860	20,731	1.16	110	169
Henderson	145,501	71,173	7,283	....	223,957	244,490	1.09	183	393
Hopkins	1,873,559	58,211	95,941	79,506	2,107,217	1,702,676	.81	178	2,652
Johnson	779,645	5,798	16,021	....	801,464	1,003,357	1.25	226	1,080
Knox	732,179	16,429	15,993	....	764,601	855,765	1.12	213	1,277
Laurel	234,133	2,426	6,169	....	242,728	254,594	1.05	209	532
Lawrence	48,473	2,344	1,329	....	52,146	45,432	.87	107	194
Lee	44,176	596	1,085	....	45,857	61,279	1.34	232	165
McLean	111,178	9,534	1,670	....	122,382	104,524	.85	121	236
Morgan	67,899	7,419	263	....	75,581	165,177	2.19	233	248
Muhlenberg	2,158,092	28,457	56,644	....	2,243,193	1,944,883	.87	157	3,485
Ohio	724,331	22,357	23,197	....	769,885	709,928	.92	163	1,192
Pike	1,006,604	12,985	13,716	33,353	1,066,658	967,070	.91	210	1,248
Union	394,312	42,603	23,329	2,439	462,683	462,132	1.00	201	611
Webster	827,546	24,379	26,541	....	878,466	743,884	.85	188	1,064
Whitley	1,148,676	19,297	14,335	....	1,182,308	1,472,777	1.25	207	2,082
Other counties [a]	181,165	6,973	2,325	....	190,463	204,847	1.08	190	357
Small mines	....	170,906	....	....	170,906	242,670	1.42	....	....
Total	12,652,280	604,617	334,444	115,498	13,706,839	13,617,217	.99	191	21,821

[a] Breathitt, Butler, Clay, Crittenden, Greenup, Hancock, Knott, Magoffin, Pulaski, and Wayne.

Coal production of Kentucky, 1907–1911, by counties, in short tons.

County.	1907	1908	1909	1910	1911	Increase (+) or decrease (−), 1911.
Bell	1,437,886	1,557,924	1,538,568	2,051,106	1,778,787	− 272,319
Boyd	55,284	61,319	86,904	103,051	109,255	+ 6,204
Breathitt and Lee	87,941	181,551	105,091	92,125	57,102	− 35,023
Butler	10,271	6,858	7,228	1,756	1,580	− 176
Carter	120,627	83,546	81,404	67,400	39,006	− 28,394
Christian, Daviess, and Hancock	150,248	128,195	121,738	117,286	111,203	− 6,083
Floyd	....	....	....	137,330	250,883	+ 113,553
Greenup	902	1,474	....	290	513	+ 223
Harlan	....	....	....	1,440	17,860	+ 16,420
Henderson	217,582	196,023	163,782	241,281	223,957	− 17,324
Hopkins	2,064,154	1,864,346	1,864,453	2,554,620	2,107,217	− 447,403
Johnson	122,590	158,270	222,746	468,609	801,464	+ 332,855
Knox	706,491	515,210	610,705	654,478	764,601	+ 110,123
Laurel	319,281	207,084	214,251	275,224	242,728	− 32,496
Lawrence	29,673	22,975	96,440	100,895	52,146	− 48,749
McLean	150,205	105,469	128,015	206,001	122,382	− 83,619
Morgan	....	....	....	70,061	75,581	+ 5,520
Muhlenberg	1,882,913	1,784,285	2,009,549	2,738,427	2,243,193	− 495,234
Ohio	658,645	601,138	626,158	819,397	769,885	− 49,512
Pike	....	....	....	953,605	1,066,658	+ 113,053
Pulaski	135,225	99,505	61,723	85,218	69,437	− 15,781
Rockcastle	6,500	....	....	5,000	....	− 5,000
Union	507,855	499,729	444,457	590,378	462,683	− 127,695
Webster	608,693	559,247	449,508	1,026,188	878,466	− 147,722
Whitley	762,923	811,114	933,154	1,167,937	1,182,308	+ 14,371
Other counties and small mines	717,235	801,291	931,510	94,216	277,944	+ 183,728
Total	10,753,124	10,246,553	10,697,384	14,623,319	13,706,839	− 916,480
Total value	$11,405,038	$10,317,162	$10,079,917	$14,405,887	$13,617,217	−$788,670

In the following table the statistics of Kentucky's coal production during the last five years are divided according to the counties in the eastern and western parts of the State. The coal areas in the eastern part of Kentucky belong to the Appalachian region, while those in the western district belong to the eastern interior region and form the southern extremity of the Illinois-Indiana field. Kentucky is the only State that has within its borders coal areas belonging to more than one of the great coal fields. It is to be observed that the western district has been the larger producer, but that the mines of the eastern district have been making notable gains in the last three years. The extensive developments that have been and are now being carried forward in the eastern district will probably give that district the supremacy within the next two years.

Coal production of the eastern district of Kentucky, 1907–1911, in short tons.

County.	1907	1908	1909	1910	1911	Increase (+) or decrease (−), 1911.
Bell	1,437,886	1,557,924	1,538,568	2,051,106	1,778,787	−272,319
Boyd	55,284	61,319	86,904	103,051	109,255	+ 6,204
Breathitt	25,300	23,100	20,982	24,432	11,245	− 13,187
Carter	120,627	83,546	81,404	67,400	39,006	− 28,394
Floyd	....	....	....	137,330	250,883	+113,553
Greenup	902	1,474	....	290	513	+ 223
Harlan	....	....	....	1,440	17,860	+ 16,420
Johnson	122,590	158,270	222,746	468,609	801,464	+332,855
Knox	706,491	515,210	610,705	654,478	764,601	+110,123
Laurel	319,281	207,084	214,251	275,224	242,728	− 32,496
Lawrence	29,673	22,975	96,440	100,895	52,146	− 48,749
Lee	62,641	158,451	84,109	67,693	45,857	− 21,836
Morgan	....	....	....	70,061	75,581	+ 5,520
Pike	....	....	....	953,605	1,066,658	+113,053
Pulaski	135,225	99,505	61,723	85,218	69,437	− 15,781
Rockcastle	6,500	....	....	5,000	....	− 5,000
Whitley	762,923	811,114	933,154	1,167,937	1,182,308	+ 14,371
Other counties and small mines	672,404	746,461	875,113	45,255	86,773	+ 41,518
Total	4,457,727	4,446,433	4,826,099	6,279,024	6,595,102	+316,078

Coal production of the western district of Kentucky, 1907–1911, in short tons.

County.	1907	1908	1909	1910	1911	Increase (+) or decrease (−), 1911.
Butler	10,271	6,858	7,228	1,756	1,580	− 176
Christain	62,901	67,040	45,453	37,136	32,418	− 4,718
Daviess	73,907	51,155	61,175	73,786	78,135	+ 4,349
Hancock	13,440	10,000	15,110	6,364	650	− 5,714
Henderson	217,582	196,023	163,782	241,281	223,957	− 17,324
Hopkins	2,064,154	1,864,346	1,864,453	2,554,620	2,107,217	− 447,403
McLean	150,205	105,469	128,015	206,001	122,382	− 83,619
Muhlenberg	1,882,913	1,784,285	2,009,549	2,738,427	2,243,193	− 495,234
Ohio	658,645	601,138	626,158	819,397	769,885	− 49,512
Union	507,855	499,729	444,457	590,378	462,683	− 127,695
Webster	608,693	559,247	449,508	1,026,188	878,466	− 147,722
Other counties and small mines	44,831	54,830	56,397	48,961	191,171	+ 142,210
Total	6,295,397	5,800,120	5,871,285	8,344,295	7,111,737	−1,232,558

So far as the records of early coal production in the United States are to be accepted, Kentucky was the third State to enter the list of regular coal producers. According to one of the early reports of the

Kentucky Geological Survey (published in 1838), the first coal produced in the State was mined in 1827 on "the right side of the (Cumberland) river below the mouth of Laurel." This was evidently from either Laurel or Pulaski County, but the exact location is not definitely stated. The same report says that in 1828 five boatloads of coal from these mines arrived at Nashville, and that from 1829 to 1834 probably from 25 to 35 boatloads were sent out each year. The boatloads averaged about 1,750 bushels, or 66 tons each. From 1834 to 1837 the shipments were from 75 to 100 boatloads, or about 3,500 bushels a year. The coal was for the most part consumed in the salt works and iron furnaces convenient to the rivers, the only means of transportation.

From the best information obtainable it seems that the production of the State from 1829 to 1835 ranged from 2,000 to 6,000 tons per year. The United States census for 1840 gives the total production for the State at 23,527 short tons. By 1860, according to the census for that year, the production amounted to 285,760 short tons. Operations were necessarily somewhat interrupted during the Civil War, but since 1870, after the State had begun to recover from the effects of the war, the production increased rapidly, as shown in the following table, showing the annual and total production from 1828 to the close of 1911:

Production of coal in Kentucky from 1828 to 1911, in short tons.

Year.	Quantity.	Year.	Quantity.	Year.	Quantity.	Year.	Quantity.
1828	328	1850	150,000	1872	380,800	1894	3,111,192
1829	2,000	1851	160,000	1873	400,000	1895	3,357,770
1830	2,000	1852	175,000	1874	360,000	1896	3,333,478
1831	2,100	1853	180,000	1875	500,000	1897	3.602,097
1832	2,500	1854	190.000	1876	650.000	1898	3,887,908
1833	2,750	1855	200,000	1877	850,000	1899	4,607,255
1834	5,000	1856	215,000	1878	900.000	1900	5,328,964
1835	6.000	1857	240,000	1879	1,000,000	1901	5,469,986
1836	8,000	1858	250,000	1880	946,288	1902	6,766,984
1837	10,000	1859	275,000	1881	1,232,000	1903	7,538,032
1838	11,500	1860	285.760	1882	1,300,000	1904	7,576,482
1839	16,000	1861	280,000	1883	1,650,000	1905	8,432,523
1840	23,527	1862	275,000	1884	1,550,000	1906	9,653,647
1841	35,000	1863	250,000	1885	1,600,000	1907	10,753,124
1842	50,000	1864	250,000	1886	1,550,000	1908	10,246,553
1843	60.000	1865	200,000	1887	1,933,185	1909	10,697,384
1844	75,000	1866	180,000	1888	2,570,000	1910	14,623,319
1845	100,000	1867	175,000	1889	2,399,755	1911	13,706,839
1846	115,000	1868	160,000	1890	2,701,496		
1847	120,000	1869	160,000	1891	2,916,069	Total.	171,678,669
1848	125,000	1870	150,582	1892	3,025,313		
1849	140,000	1871	250,000	1893	3,007,179		

MARYLAND.

Total production in 1911, 4,685,795 short tons; spot value, $5,197,066.

Compared with 1910, when the coal production in Maryland amounted to 5,217,125 short tons, valued at $5,835,058, the output in 1911 showed a decrease of 531,330 short tons, or 10.2 per cent, in quantity and of $637,992, or 10.9 per cent, in value. Stimulated, as the other Appalachian States had been in 1910, by the strike of miners in the Middle West, the production in Maryland had increased nearly 1,200,000 tons over 1909, and a part of the markets secured at that time were held in 1911, but not sufficiently to maintain the tonnage won in 1910. The coal fields of Maryland are not of wide extent and the production during the 90 years of their exploitation has been chiefly from the "Maryland Big Vein," an outlier of the famous Pittsburgh bed of Pennsylvania, that had a development of from 10 to 13 feet in the western part of Allegany County in Maryland and extended southward into Mineral County in West Virginia. Mining operations covering nearly a century have exhausted a large part of this great coal bed in Maryland, and during the three or four years preceding 1910 the production of the State had shown a declining tendency as some of the mines were being worked out. The production will probably continue to decline until the thinner beds, both above and below the Pittsburgh, are more extensively developed, and as these beds in the aggregate contain many times more coal than that originally contained in the "Big Vein," Maryland still possesses an important supply from which to draw. The exploitation of the thinner beds already begun has been attended with satisfactory results, especially in Garrett County. In fact, Garrett County, which a decade ago was hardly considered of much importance as a coal producer, is now contributing from 15 to 20 per cent of the total output of the State, having in 1911 a production of 805,586 short tons.

Of the total production in 1911 of 4,685,795 tons, 154,301 tons, or 3.3 per cent, were undercut by machines, of which there were 37 in use. In 1910 there were 38 machines in use, and the machine-mined product was 137,216 tons. With the further development of the thinner beds where the conditions for machine-mining are more favorable than in the "Big Vein," the tonnage to be won by machines will increase.

The coal mines of Maryland gave employment in 1911 to 5,881 men, who worked an average of 248 days, against 5,809 men for an average of 270 days in 1910. The average production for each man employed in 1911 was considerably below that of 1910, the figures for the two years being, respectively, 796.8 tons and 898 tons, the difference being due probably to the smaller production from the "Big Vein." Notwithstanding the apparent decrease in productive efficiency in 1911, and notwithstanding the fact that only 3.3 per cent of Maryland's production was undercut by machines, the miners in the State show a larger average production than the general average for all the States.

The average production per day by each employee was 3.33 tons in 1910 and 3.21 in 1911. The coal mines in Maryland are operated 10 hours a day. They have been usually free from labor troubles, and 1911 was no exception to the rule. It is gratifying to state that in reply to Survey inquiries regarding the quantity of coal shot from the solid and undercut by hand, only three companies reported their employees as having indulged in the reprehensible practice of "solid shooting." With no strikes reported, with a productive efficiency considerably above the average, and with little or no coal shot from the solid, the coal operators and coal miners of Maryland are to be felicitated on their record. Maryland is also to be felicitated on a death rate by accident of less than 3 per thousand, the rate for 1911 being 2.55. The United States Bureau of Mines reports a total of 15 deaths in the coal mines of Maryland in 1911. Of these 12, or 80 per cent, were due to falls of roof or coal. There were 312,386 tons mined for each life lost.

The statistics of the production of coal in Maryland in 1910 and 1911, with the distribution of the product for consumption, are shown in the following table:

Coal production of Maryland in 1910 and 1911, by counties, in short tons.

1910.

County.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Total quantity.	Total value.	Average price per ton.	Average number of days active.	Average number of employees.
Allegany	4,253,749	43,879	53,632	4,351,260	$5,103,608	$1.17	272	4,939
Garrett	843,598	4,908	3,386	851,892	715,263	.84	259	870
Small mines	....	13,973	....	13,973	16,187	1.16	....	....
Total	5,097,347	62,760	57,018	5,217,125	5,835,058	1.12	270	5,809

1911.

County.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Total quantity.	Total value.	Average price per ton.	Average number of days active.	Average number of employees.
Allegany	3,752,185	48,655	63,355	3,864,195	$4,554,978	$1.18	247	4,923
Garrett	795,415	7,381	2,790	805,586	623,313	.78	226	958
Small mines	....	16,014	....	16,014	18,775	1.17	....	....
Total	4,547,600	72,050	66,145	4,685,795	5,197,066	1.11	248	5,881

The statistics of production during the last five years, with the distribution of the product for consumption, are shown in the following table:

Distribution of the coal product of Maryland, 1907–1911, in short tons.

Year.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Total quantity.	Total value.	Average price per ton.	Average number of days active.	Average number of employees.
1907	5,427,882	48,461	56,285	5,532,628	$6,623,697	$1.20	263	5,880
1908	4,288,306	38,054	50,733	4,377,093	5,116,753	1.17	220	6,079
1909	3,917,803	55,882	49,556	4,023,241	4,471,731	1.11	....	8,004
1910	5,097,347	62,760	57,018	5,217,125	5,835,058	1.12	270	5,809
1911	4,547,600	72,050	66,145	4,685,795	5,197,066	1.11	248	5,881

Comparisons of the total production by counties in 1910 and 1911 are shown in the following table:

Coal production of Maryland, 1910 and 1911, by counties, in short tons.

County.	1910	1911	Increase (+) or decrease (−), 1911.
Allegany	4,351,260	3,864,195	− 487,065
Garrett	851,892	805,586	− 46,306
Small mines	13,973	16,014	+ 2,041
Total	5,217,125	4,685,795	− 531,330
Total value	$5,835,058	$5,197,066	−$637,992

Although coal was discovered in the Georges Creek basin as early as 1782, the first eastern shipments from the Maryland coal district were not made until 1830, when small quantities were transported by barges down the Potomac River. The first company was incorporated in 1836. After the construction of the Baltimore & Ohio Railroad, in 1842, and of the Chesapeake & Ohio Canal, in 1850, the output from the Maryland mines increased rapidly.

The attempt to ship coal from the Maryland mines by barges, prior to the advent of the Baltimore & Ohio Railroad, was not long continued. The method was too destructive of life and was the cause of so much loss in coal that it was soon abandoned, and it was not until 1842 that the industry really began to assume importance. The first shipments over the Chesapeake & Ohio Canal from Cumberland were made in 1850.

Maryland and the adjoining counties in West Virginia which make up what is known as the Cumberland region constitute the only districts outside of the anthracite region of Pennsylvania where records of coal production have been kept from the earliest years. These districts have been commonly known as the Georges Creek or Cumberland and the Piedmont regions. The Cumberland region was opened in 1842. The Piedmont region began shipping in 1853. The records of shipment have been carefully preserved and are published annually in the reports of the Cumberland coal trade.

The annual production from the coal mines of Maryland from 1820 to the close of 1911 has been as follows:

Production of coal in Maryland from 1820 to 1911, in short tons.

Year.	Quantity.	Year.	Quantity.	Year.	Quantity.	Year.	Quantity.
1820	3,000	1858	722,686	1877	1,939,575	1896	4,143,936
1832	12,000	1859	833,349	1878	2,068,925	1897	4,442,128
1840	8,880	1860	438,000	1879	2,132,233	1898	4,674,884
1842	2,104	1861	287,073	1880	2,228,917	1899	4,807,396
1843	12,421	1862	346,201	1881	2,533,348	1900	4,024,688
1844	18,345	1863	877,313	1882	1,555,445	1901	5,113,127
1845	30,372	1864	755,764	1883	2,476,075	1902	5,271,609
1846	36,707	1865	1,025,208	1884	2,765,617	1903	4,846,165
1847	65,222	1866	1,217,668	1885	2,833,337	1904	4,813,622
1848	98,032	1867	1,381,429	1886	2,517,577	1905	5,108,539
1849	175,497	1868	1,529,879	1887	3,278,023	1906	5,435,453
1850	242,517	1869	2,216,300	1888	3,479,470	1907	5,532,628
1851	317,460	1870	1,819,824	1889	2,939,715	1908	4,377,093
1852	411,707	1871	2,670,338	1890	3,357,813	1909	4,023,241
1853	657,862	1872	2,647,156	1891	3,820,239	1910	5,217,125
1854	812,727	1873	3,198,911	1892	3,419,962	1911	4,685,795
1855	735,137	1874	2,899,392	1893	3,716,041		
1856	817,659	1875	2,808,018	1894	3,501,428	Total	165,909,802
1857	654,017	1876	2,126,873	1895	3,915,585		

MICHIGAN.

Total production in 1911, 1,476,074 short tons; spot value, $2,791,461.

Michigan's coal production reached its maximum record in 1907 when a total of 2,035,858 short tons was attained. Since 1907 the production has decreased each year, competition of higher grade Pennsylvania coal brought by water to the Lake ports being the principal factor in curtailing the Michigan output. From the maximum of 1907 the production in 1910 showed a decline of almost exactly 500,000 tons, to 1,534,967 tons. The decrease from 1910 to 1911 was 58,893 short tons, or 3.84 per cent. The value declined

$139,310, or 4.75 per cent, and the average price per ton declined from $1.91 to $1.89.

The coal production of Michigan is chiefly from the two counties of Bay and Saginaw, and is nearly equally divided between them, Bay County having the larger tonnage in the last two years, though prior to 1910 Saginaw was the more important producer. Other counties in the State producing coal are Clinton, Eaton, Genesee, Jackson, Shiawassee, and Tuscola. One of the chief markets for the product are the salt-evaporating plants which in former days were operated in connection with lumber mills, the refuse from which furnished the fuel for the salt works. The decline of the lumber industry compelled the salt works to turn to coal as a fuel.

The number of men employed in the coal mines of Michigan decreased from 3,575 in 1910 to 3,323 in 1911, but the average number of working days increased (on account of the strike idleness in 1910) from 211 to 218. The average production per man increased from 429 tons in 1910 to 444 in 1911, and the average daily tonnage per man increased from 2.03 to 2.04. The coal mines of Michigan were entirely free from strikes or other labor troubles during 1911.

The quantity of coal mined by machines was about one-half the total production, amounting in 1911 to 734,246 short tons, out of the total production of 1,476,074. There were 113 machines employed, an increase of 13 over 1910. The increase in the machine-mined production over 1910, when 698,191 tons were so mined, was 36,055 tons. Only 11 per cent of Michigan's coal is mined by hand, whereas 37 per cent is shot from the solid. The quantity reported as mined by hand in 1911 was 158,480 tons, while that shot from the solid was 548,858 tons, the latter being 3½ times the former. The Consolidated Coal Co. of Saginaw, which operated a number of machines, has installed coal-washing machinery at eight of its plants. In 1911 the quantity of coal washed was 234,063 short tons, yielding 207,135 tons of cleaned coal and 26,928 tons of refuse. In 1910, 186,128 tons were washed, yielding 159,971 tons of cleaned coal and 26,157 tons of refuse.

There were 7 men killed in the coal mines of Michigan in 1911 and of these 4 were killed by falls of roof or coal. The death rate was low, 2.1 per thousand and there were 210,868 tons mined for each fatality.

The statistics of the production of coal in Michigan, by counties, during 1910 and 1911, with the distribution of the product for consumption, are shown in the following table:

Coal production of Michigan in 1910 and 1911, by counties, in short tons.

1910.

County.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Total quantity.	Total value.	Average price per ton.	Average number of days active.	Average number of employees.
Bay	699,544	36,637	30,289	766,470	$1,432,293	$1.87	220	1,554
Saginaw	583,399	57,507	26,376	667,282	1,290,933	1.93	206	1,740
Other counties [a] and small mines	72,876	16,329	12,010	101,215	207,545	2.05	188	281
Total	1,355,819	110,473	68,675	1,534,967	2,930,771	1.91	211	3,575

[a] Clinton, Eaton, Genesee, Ingham, Shiawassee, and Tuscola.

Coal production of Michigan in 1910 and 1911, by counties, in short tons—Continued.

1911.

County.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Total quantity.	Total value.	Average price per ton.	Average number of days active.	Average number of employees.
Bay	676,787	7,399	32,898	717,084	$1,320,484	$1.84	211	1,586
Saginaw	595,663	52,406	19,885	667,954	1,267,652	1.90	225	1,451
Other counties [a] and small mines	74,694	10,322	6,020	91,036	203,325	2.23	222	286
Total	1,347,144	70,127	58,803	1,476,074	2,791,461	1.89	218	3,323

[a] Clinton, Eaton, Genesee, Ingham, Shiawassee, and Tuscola.

The statistics of production, by counties, during the last five years, with increase and decrease in 1911 as compared with 1910, are shown in the following table:

Coal production of Michigan, 1907–1911, by counties, in short tons.

County.	1907	1908	1909	1910	1911	Increase (+) or decrease (−), 1911.
Bay	962,574	782,503	822,577	766,470	717,084	− 49,386
Eaton	5,982	2,286	558	100	1,000	+ 900
Jackson	5,645	5,539	1,500			
Saginaw	1,047,927	999,338	859,434	667,282	667,954	+ 672
Shiawassee	13,730	[a] 45,353	[b] 100,623	[c] 101,115	[c] 90,036	− 11,079
Total	2,035,858	1,835,019	1,784,692	1,534,967	1,476,074	− 58,893
Total value	$3,660,833	$3,322,904	$3,199,351	$2,930,771	$2,791,461	−$139,310

[a] Clinton and Tuscola counties and small mines.
[b] Includes Clinton, Ingham, and Tuscola counties and small mines.
[c] Includes Clinton, Genesee, Ingham, and Tuscola counties and small mines.

Coal was known to exist in Michigan early in the last century, and some mining is said to have been done in the Jackson field as early as 1835. Other mines were opened at Grand Ledge, in Clinton County, in 1838. It is known that some coal was produced at that place in those early years, but there is no record of the output prior to the census report of 1860, in which year Michigan was credited with a production of 2,320 tons. The development of mining in this field has been tardy, however, owing largely to the fact that one of the principal industries of the vicinity, the manufacture of salt, had been carried on in connection with sawmills, and that the sawdust and other refuse from these mills were used as fuel. Wood also formed the chief fuel for other manufacturing industries and for domestic use. It was only in the closing decade of the last century that serious attention began to be paid to the coal resources of the State, and prior to 1896 the production had exceeded 100,000 tons during four years only. In 1897 it exceeded 200,000 tons; in 1899 it exceeded 600,000 tons; and in the first year of the present century it reached a total exceeding 1,200,000 tons. The maximum output of 2,035,858 tons was reached in 1907.

The record, by years, from 1860 to 1911, inclusive, is shown in the following table:

Production of coal in Michigan, 1860 to 1911, in short tons.

Year.	Quantity.	Year.	Quantity.	Year.	Quantity.	Year.	Quantity.
1860	2,320	1874	58,000	1888	81,407	1902	964,718
1861	3,000	1875	62,500	1889	67,431	1903	1,367,619
1862	5,000	1876	66,000	1890	74,977	1904	1,342,840
1863	8,000	1877	69,197	1891	80,307	1905	1,473.211
1864	12,000	1878	85,322	1892	77,990	1906	1,346,338
1865	15,000	1879	82,015	1893	45,979	1907	2,035,858
1866	20,000	1880	100,800	1894	70,022	1908	1,835,019
1867	25,000	1881	112,000	1895	112,322	1909	1,784,692
1868	28,000	1882	135,339	1896	92,882	1910	1,534,967
1869	29,980	1883	71,296	1897	223,592	1911	1,476,074
1870	28,150	1884	36,712	1898	315,722		
1871	32,000	1885	45,178	1899	624,708	Total.	20,473,695
1872	33,600	1886	60,434	1900	849.475		
1873	56,000	1887	71,461	1901	1,241,241		

MISSOURI.

Total production in 1911, 3,760,607 short tons; spot value, $6,431,066.

Missouri's coal production showed a notable gain in 1911 over 1910, and with the exception of 1907, exceeded the output of any of the five years from 1906 to 1910. In 1910 coal-mining operations in Missouri were (in common with the other States of the Mississippi Valley region) suspended for a good part of the year on account of labor troubles, resulting in a decrease in output for Missouri from 3,756,530 short tons in 1909 to 2,982,433 tons in 1910. The industry was practically free from labor disturbances in 1911, and the output recovered to 3,760,607 tons, and increase of 778,174 tons, or 26.1 per cent. The value increased from $5,328,285 to $6,431,066, a gain of $1,102,781, or 20.7 per cent. The lower ratio of increase in value in 1911 was due to the higher prices that obtained during the shortage caused by the strike in 1910. The average price in 1911 was $1.71 per short ton compared with $1.79 in 1910. In 1909 the average price was $1.65. The increase in value in 1911 over 1910 reflects the advance in the wage scale following the strike of 1910. The most pronounced increases in 1911 were in Randolph County, which gained over 150 per cent, from 193,482 tons in 1910 to 483,800 tons in 1911, and in Lafayette County, which gained 212,047 tons. The increase in Randolph County was due to the rejuvenation of the properties formerly owned by the Randolph-Macon Coal Co., which were taken over in 1909 by the Northern Central Coal Co., and operations were actively pushed during 1910 and 1911.

The production in the State during 1911 was normal, and no marked increase in the future above that due to increased population in the rural districts may be looked for. Missouri is surrounded by other important coal-producing States, where mining conditions are better than in most of the Missouri districts, and the larger cities of the State, St. Louis and Kansas City, draw their fuel supplies in great part from the bordering States. The markets for Missouri coals are restricted to comparatively local territory, largely rural, and the railroads. Illinois coals to the east are the principal competitors. The industry in Missouri suffers also, however, from competition with oil and natural gas, but not to the same extent as does that of Arkansas, Kansas, and Oklahoma. Natural gas from eastern Kansas is used in Kansas City, St. Joseph, and Joplin, but probably displaces more of Arkansas and Oklahoma coals than it does the product of the Missouri mines.

The coal mines of Missouri in 1911 gave employment to 9,991 men, who worked an average of 183 days, against 9,691 men for an average of 154 days in 1910. The average output for each man employed was 376.4 tons in 1911 as against 308 tons in 1910. The average production per man per day was 2 tons in both years.

Long-wall mining is practised to a greater relative extent in Missouri than elsewhere in the United States, and most of the mining machines employed are of the long-wall type. In 1911 out of a total of 92 machines, 75 were long-wall, the other 17 being punchers. The quantity of coal mined by machines in 1911 was 753,614 short tons, against 553,656 tons in 1910. Shooting from the solid is practised to an unfortunate degree. Out of a total production of 2,579,361 short tons in 1911, for which the method of mining was reported, outside of the machine-mined products, 1,893,429 tons, or 73 per cent, were shot without being undercut or sheared, and 685,932 tons, or 27 per cent, were hand mined. The total undercut by machines and by hand was 1,439,546 tons, whereas 1,893,429 tons were not properly mined.

To Missouri's coal production, as reported by the Survey annually during the last few years, should be added a considerable tonnage credited to Kansas. The working of the mines at Leavenworth, Kans., on Missouri River, extend under that boundary line into Missouri territory, and the larger part of the production of Leavenworth County, Kans., is, in fact, mined in Platte County, Mo. This probably amounts to 250,000 tons a year. It has been customary, however, when mine workings extend from one State or county into another, to credit the output to the State or county in which the tipple is located. For this reason the tonnage from Platte County, Mo., appears as coming from Leavenworth County, Kans.

Missouri coal mines had the lowest death rate in 1911 of all States—0.8 per thousand. The quantity of coal mined for each life lost was 470,076 tons, an unusually high figure. The United States Bureau of Mines reported 8 men killed, 7 of whom met death by falls of roof or coal.

The statistics of coal production in Missouri in 1910 and 1911, by counties, with the distribution of the product for consumption, are shown in the following table:

Coal production of Missouri in 1910 and 1911, by counties, in short tons.

1910.

County.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Total quantity.	Total value.	Average price per ton.	Average number of days active.	Average number of employees.
Adair	380,892	23,343	3,772	408,007	$675,979	$1.66	126	1,349
Audrain	21,189	17,252	2,221	40,662	85,014	2.09	237	155
Barton	216,095	2,896	3,604	222,595	350,501	1.57	188	502
Bates	80,238	14,453	760	95,451	168,802	1.77	145	273
Boone	2,437	17,354	94	19,885	41,001	2.06	219	62
Callaway	....	28,844	110	28,954	65,730	2.27	211	97
Henry	126,133	15,996	3,515	145,644	252,958	1.74	153	441
Lafayette	493,457	45,190	15,185	553,832	1,100,635	1.99	167	2,087
Linn	67,336	20,285	1,690	89,311	197,874	2.22	150	396
Macon	583,734	20,511	9,704	613,949	911,625	1.48	145	1,694
Putnam	55,996	5,292	680	61,968	123,424	1.99	184	213
Ralls	11,818	943	....	12,761	24,118	1.89	205	57
Randolph	163,744	25,043	4,695	193,482	314,864	1.63	132	707
Ray	265,374	21,208	5,860	292,442	590,000	2.02	159	1,217
Other counties [a]	44,049	41,454	4,481	89,984	197,555	2.20	141	441
Small mines	....	113,506	....	113,506	228,205	2.01	....	....
Total	2,512,492	413,570	56,371	2,982,433	5,328,285	1.79	154	9,691

1911.

County.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Total quantity.	Total value.	Average price per ton.	Average number of days active.	Average number of employees.
Adair	320,126	21,015	7,418	348,559	$546,876	$1.57	148	1,032
Audrain	9,636	17,742	2,295	29,673	69,372	2.34	161	158
Barton	270,242	20,901	4,093	295,236	425,029	1.44	196	550
Bates	72,822	13,543	2,255	88,620	152,347	1.72	153	251
Boone	3,237	18,633	161	22,031	46,093	2.09	212	79
Callaway	....	36,211	200	36,411	86,309	2.37	231	116
Henry	217,785	19,621	3,165	240,571	422,773	1.76	217	412
Lafayette	697,973	49,694	18,212	765,879	1,391,279	1.82	205	2,201
Linn	102,351	18,058	2,760	123,169	281,581	2.29	217	378
Macon	647,373	19,230	9,330	675,933	1,009,953	1.49	139	1,916
Putnam	24,377	5,129	770	30,276	54,279	1.79	99	191
Ralls	15,459	699	....	16,158	30,413	1.88	245	44
Randolph	448,977	22,563	12,260	483,800	742,578	1.53	222	1,085
Ray	283,234	28,317	5,583	317,134	619,303	1.95	180	1,077
Other counties [b]	116,882	55,844	5,315	178,041	327,353	1.84	211	501
Small mines	....	109,116	....	109,116	225,528	2.07	....	....
Total	3,230,474	456,316	73,817	3,760,607	6,431,066	1.71	183	9,991

[a] Caldwell, Carroll, Cass, Clay, Cole, Dade, Grundy, Harrison, Howard, Johnson, Livingston, Moniteau, Montgomery, Saline, Schuyler, Sullivan, and Vernon.

[b] Caldwell, Cass, Clay, Cole, Dade, Grundy, Harrison, Howard, Johnson, Moniteau, Montgomery, Schuyler, Sullivan, and Vernon.

The statistics of production during the last five years, by counties, with increase and decrease in 1911 as compared with 1910, are shown in the following table:

Coal production in Missouri, 1907–1911, by counties, in short tons.

County.	1907	1908	1909	1910	1911	Increase (+) or decrease (−), 1911.
Adair	585,491	600,352	576,485	408,007	348,559	− 59,448
Audrain	38,265	37,479	41,207	40,662	29,673	− 10,989
Barton	193,418	129,632	259,766	222,595	295,236	+ 72,641
Bates	115,285	133,700	147,322	95,451	88,620	− 6,831
Boone	33,034	25,868	18,000	19,885	22,031	+ 2,146
Caldwell	15,000	10,600	7,815	7,300	3,181	− 4,119
Callaway	34,413	22,534	25,179	28,954	36,411	+ 7,457
Grundy	11,040	10,821	9,818	9,640	8,000	− 1,640
Henry	209,652	219,974	263,352	145,644	240,571	+ 94,927
Johnson	10,543	13,571	8,128	2,532	1,500	− 1,032
Lafayette	717,588	595,678	715,223	553,832	765,879	+ 212,047
Linn	117,403	103,104	134,260	89,311	123,169	+ 33,858
Livingston	2,010	1,010	400	200	....	− 200
Macon	1,156,140	833,060	790,083	613,949	675,933	+ 61,984
Montgomery and Morgan	....	2,783	2,420	*a* 1,500	*a* 1,000	− 500
Putnam	51,675	50,775	48,120	61,968	30,276	− 31,692
Ralls	12,024	11,802	16,009	12,761	16,158	+ 3,397
Randolph	72,500	66,391	186,573	193,482	483,800	+ 290,318
Ray	337,384	263,288	277,075	292,442	317,134	+ 24,692
Vernon	141,379	47,281	20,278	7,208	2,658	− 4,550
Other counties and small mines	143,692	137,612	209,017	175,110	270,818	+ 95,708
Total	3,997,936	3,317,315	3,756,530	2,982,433	3,760,607	+ 778,174
Total value	$6,540,709	$5,444,907	$6,183,626	$5,328,285	$6,431,066	+$1,102,781

a Montgomery County only.

As far as any records are obtainable, coal mining began in Missouri in 1840, the United States Census for that year recording a production of 9,972 tons. The production since 1840 is shown in the following table, the output of the years 1841 to 1869, inclusive, being estimated from the best information available.

A statement of the annual production of coal in Missouri from 1840 to the close of 1911 will be found in the following table:

Production of coal in Missouri from 1840 to 1911, in short tons.

Year.	Quantity.	Year.	Quantity.	Year.	Quantity.	Year.	Quantity.
1840	9,972	1859	260,000	1878	1,008,000	1897	2,665,626
1841	12,000	1860	280,000	1879	1,008,000	1898	2,688,321
1842	15,000	1861	300,000	1880	844,304	1899	3,025,814
1843	25,000	1862	320,000	1881	1,960,000	1900	3,540,103
1844	35,000	1863	360,000	1882	2,240,000	1901	3,802,088
1845	50,000	1864	375,000	1883	2,520,000	1902	3,890,154
1846	68,000	1865	420,000	1884	2,800,000	1903	4,238,586
1847	80,000	1866	450,000	1885	3,080,000	1904	4,168,308
1848	85,000	1867	500,000	1886	1,800,000	1905	3,983,378
1849	90,000	1868	541,000	1887	3,209,916	1906	3,758,008
1850	100,000	1869	550,000	1888	3,909,967	1907	3,997,936
1851	125,000	1870	621,930	1889	2,557,823	1908	3,317,315
1852	140,000	1871	725,000	1890	2,735,221	1909	3,756,530
1853	160,000	1872	784,000	1891	2,674,606	1910	2,982,433
1854	175,000	1873	784,000	1892	2,733,949	1911	3,760,607
1855	185,000	1874	789,680	1893	2,897,442		
1856	200,000	1875	840,000	1894	2,245,039	Total.	111,434,991
1857	220,000	1876	1,008,000	1895	2,372,393		
1858	240,000	1877	1,008,000	1896	2,331,542		

MONTANA.

Total production in 1911, 2,976,358 short tons; spot value, $5,342,168.

Montana's coal production has increased steadily during the last three years, the gains being due chiefly to the developments in the Bull Mountain field which was opened in 1908, following the construction through it of the Chicago, Milwaukee & Puget Sound Railway. In its increased production in 1911 over 1910 Montana was a marked exception to the prevalent condition among the Rocky Mountain States. The increase was not large, but in a year of general decrease it was relatively important, though attended by a slight decline in price. In 1910 the production of the State amounted to 2,920,970 short tons, valued at $5,329,322; in 1911 it was 2,976,358 tons, valued at $5,342,168. The increase in quantity was 55,388 tons, or not quite 2 per cent, and the gain in value was $12,846, or 0.2 per cent. In 1910 the production of the Bull Mountain field was divided between Fergus and Yellowstone counties. In 1911 a new county, Musselshell, was created, which embraces all of this new field, and the new county appears with a production of 706,364 tons, while Fergus County drops from 287,614 tons in 1910 to 16,711 tons in 1911, and Yellowstone is not included among the coal-producing counties. Some of the Montana coals possess coking quality and considerable quantities of coke have been made in Park County. All of the ovens were idle, however, in 1911.

The number of men reported as employed in the coal mines of Montana in 1911 was 3,866, who made an average of 220 days, against 3,837 men for 239 days in 1910. The average production per man was 770 tons for the year, and 3.5 tons for each working day in 1911, and 762 tons for the year and 3.19 per day in 1910.

Of the total production, 1,172,582 tons, or 39 per cent, were mined in 1911 by machines, of which there were 87 in use, against 866,401 tons mined by the use of 99 machines in 1910. The 87 machines in 1911 included 56 punchers, 18 chain-breast machines, 11 short-wall or continuous cutters, and 2 radialaxe or post cutters.

There were 28 mining companies (with a total production of 2,945,985 short tons) which reported the methods practiced in the mining of the coal. Of this production (2,945,985 tons), 1,172,582 tons were mined by the use of machines. Of the remaining 1,773,403 short tons, 764,938 tons, or 43 per cent, were mined by hand, and 1,008,465 tons, or 57 per cent, were shot from the solid. The quantity shot from the solid represented 34 per cent of the total production where mining methods were reported, and 66 per cent was represented by the tonnage won by hand or undercut by machine.

Only two cases of labor disturbances were reported during 1911. In one 118 men were idle 20 days, and in the other 411 were idle 14 days. The total time lost was not sufficient to influence the production.

The accident statistics compiled by the United States Bureau of Mines show that 13 men were killed (10 of them by falls of roof or coal and 2 by mine cars or motors) in the coal mines of Montana in 1911. The mortality rate was 3.36 per thousand employees. The coal mined for each fatality was 228,951 tons.

The statistics of production, by counties, in 1910 and 1911, with the distribution of the product for consumption, are shown in the following table:

Coal production of Montana in 1910 and 1911, by counties, in short tons.

1910.

County.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Made into coke.	Total quantity.	Total value.	Average price per ton.	Average number of days active.	Average number of employees.
Carbon	1,138,797	18,791	53,440		1,211,028	$2,470,205	$2.04	257	1,751
Cascade	854,615	40,431	33,260		928,306	1,425,820	1.54	223	1,098
Chouteau	5,472	11,180	675		17,327	46,286	2.67	153	72
Fergus	257,422	20,117	10,075		287,614	523,119	1.82	300	297
Park	53,911	3,623	3,381	37,519	98,434	211,655	2.15	170	350
Other counties [a]	346,870	3,974	23,920		374,764	644,889	1.72	227	269
Small mines		3,497			3,497	7,348	2.10		
Total	2,657,087	101,613	124,751	37,519	2,920,970	5,329,322	1.82	239	3,837

1911.

County.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Made into coke.	Total quantity.	Total value.	Average price per ton.	Average number of days active.	Average number of employees.
Carbon	1,080,301	19,801	85,087		1,185,189	$2,350,580	$1.98	214	1,721
Cascade	932,625	23,388	38,030		994,043	1,577,869	1.59	242	1,149
Chouteau		9,527	200		9,727	26,640	2.74	205	30
Fergus	3,702	12,076	933		16,711	51,499	3.08	166	36
Musselshell	677,627	5,923	22,814		706,364	1,193,363	1.69	201	801
Other counties [b]	45,274	5,251	8,780		59,305	131,049	2.21	236	129
Small mines		5,019			5,019	11,168	2.23		
Total	2,739,529	80,985	155,844		2,976,358	5,342,168	1.79	220	3,866

[a] Broadwater, Gallatin, Missoula, Rosebud, Valley, and Yellowstone.
[b] Gallatin, Missoula, Park, and Valley.

In the following table is presented a statement of the coal production of Montana, by counties, during the last five years, with increase and decrease in 1911 as compared with 1910:

Production of coal in Montana, 1907–1911, by counties, in short tons.

County.	1907	1908	1909	1910	1911	Increase (+) or decrease (−), 1911.
Carbon	746,110	868,112	989,664	1,211,028	1,185,189	− 25,839
Cascade	1,026,223	811,215	954,657	928,306	994,043	+ 65,737
Chouteau	24,847	19,770	31,432	17,327	9,727	− 7,600
Fergus	45,760	90,318	221,663	287,614	16,711	−270,903
Gallatin	69,257	15,973	16,771	22,465	8,515	− 13,950
Musselshell					706,364	+706,364
Park	102,555	106,942	139,464	98,434	46,333	− 52,101
Other counties and small mines	2,105	7,830	200,289	355,796	9,476	−346,320
Total	2,016,857	1,920,190	2,553,940	2,920,970	2,976,358	+ 55,388
Total value	$3,907,082	$3,771,248	$5,036,942	$5,329,322	$5,342,168	+$12,846

The first record of coal production in Montana was 31 years ago, in 1880, when the output amounted to only 224 tons. Up to 1888 the development had been rather slow, amounting to 41,467 tons in that year. In 1889 it rose to 363,301 tons and increased rapidly until 1895, when it reached a total of about 1,500,000 tons, and averaged approximately that quantity each year until 1904. Since 1904 it has shown an increasing tendency, reaching the maximum of 2,976,358 short tons in 1911.

The annual production from 1880 to 1911 is shown in the following table:

Production of coal in Montana from 1880 to 1911, in short tons.

Year.	Quantity.	Year.	Quantity.	Year.	Quantity.	Year.	Quantity.
1880	224	1889	363,301	1898	1,479,803	1907	2,016,857
1881	5,000	1890	517,477	1899	1,496,451	1908	1,920,190
1882	10,000	1891	541,861	1900	1,661,775	1909	2,553,940
1883	19,795	1892	564,648	1901	1,396,081	1910	2,920,970
1884	80,376	1893	892,309	1902	1,560,823	1911	2,976,358
1885	86,440	1894	927,395	1903	1,488,810		
1886	49,846	1895	1,504,193	1904	1,358,919	Total	35,110,591
1887	10,202	1896	1,543,445	1905	1,643,832		
1888	41,467	1897	1,647,882	1906	1,829,921		

NEVADA.

During 1911 development work was begun in Nevada on a bed of lignite at Coaldale, in Esmeralda County. Up to January, 1912, a shaft 340 feet deep had been sunk and drifts aggregating 130 feet in length had been run. A small quantity of lignite was taken out in the course of the development work, but none was sold. The mine is 4½ miles from the Tonopah & Goldfield Railroad. It is a long distance from any other coal, and there should be a considerable market for it among the gold and silver mining camps of the vicinity.

The discovery of another bed of coal in Nevada has been reported in Douglas County, near the California line,[1] but as far as could be ascertained no development work was performed on the property during 1911.

NEW MEXICO.

Total production in 1911, 3,148,158 short tons; spot value $4,525,925.

In common with most of the States in the Rocky Mountain region the coal production of New Mexico in 1911 was less than in 1910. Several causes contributed to the decreased production—(1) unusually mild weather in the winter of 1910–11, (2) a drought in the Great Plains States which reduced the demands for domestic use, (3) a decreased consumption by railroad locomotives, and (4) the resumption of coal mining in the Central and Southwestern States following the six-months' strike of 1910. The combined effect of these influences on the coal production of New Mexico was a decrease of 360,163 short tons, or 10.3 per cent, from 3,508,321 tons in 1910 to 3,148,158 tons in 1911. The value declined from $4,877,151 to $4,525,925, a decrease of $351,226, or 7.2 per cent. The smaller proportionate decrease in value was more apparent than real, for in Colfax County, which produces 75 per cent of the total output of the State, a large part of the production is taken by railroad and smelting interests affiliated with the coal-mining companies and the fixing of the price is largely a matter of accounting. The average price for the product of Colfax County in 1911 was reported as $1.33 per ton against $1.25 per ton in 1910. Colfax County sustained the greater part of the decrease in 1911, the production in that county being 353,974 tons, or 13.3 per cent, less than in 1910. All of the other counties showed decreases in production except McKinley County, which increased 32,635 short tons. Colfax County, in addition to being by long odds the largest producer, is also the only county in which coking operations are carried on, and 767,108 tons of coal mined in that county were made into coke in 1911. In that respect also there was an improvement in 1911 over 1910, when the coal made into coke amounted to 701,204 tons.

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[1] Eng. and Min. Jour., Dec. 3, 1910.

The number of men employed in the coal mines of New Mexico in 1911 was 4,007, who worked an average of 230 days, against 3,585 for an average of 283 days in 1910. The average production for each employee in 1911 was 785.7 tons for the year and 3.41 tons per day, against 979 tons and 3.46 tons, respectively, in 1910.

Although a comparatively small portion of New Mexico's product is undercut by machines, there is very little coal shot from the solid. Nearly all of it is either undercut or sheared by hand, and it is a credit to the new State that the methods employed to secure safety in its larger mines are of the best known. In the larger mines shotfirers are employed to shoot down the coal, and every precaution is taken to see that the coal is properly undercut or sheared, that the holes are properly drilled, and that the shots are properly placed before they are fired. In some cases the shooting is done by electricity, the current being turned on from outside the mine, and no shooting is done until after every man is known to have left the mine. In 1911, out of a total production of 3,148,158 short tons of coal, 93,722 tons, or 3 per cent, were undercut by machines, of which 10 were reported in use. In 1910 there were 3 machines employed, by which 71,609 tons of coal were mined.

Accidents in the coal mines of New Mexico caused the death of 21 employees, 18 underground and 3 on the surface. Of the 18 deaths underground 16 were due to falls of roof or coal. The death rate was unusually high (5.24 per thousand) and was an unfortunate introduction of the new State. The quantity of coal produced for each life lost was correspondingly low, 149,912 tons.

The statistics of production, by counties, during 1910 and 1911, with the distribution of the product for consumption, are shown in the following table:

Coal production of New Mexico in 1910 and 1911, by counties, in short tons.

1910.

County.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Made into coke.	Total quantity.	Total value.	Average price per ton.	Average number of days active.	Average number of employees.
Colfax	1,921,535	13,038	15,808	701,204	2,651,585	$3,310,412	$1.25	294	2,512
McKinley	673,481	5,727	19,522	....	698,730	1,161,951	1.66	252	766
Other counties [a]	125,625	13,677	10,718	....	150,020	391,156	2.61	275	307
Small mines	....	7,986	....	....	7,986	13,632	1.71	....	....
Total	2,720,641	40,428	46,048	701,204	3,508,321	4,877,151	1.39	283	3,585

[a] Lincoln, Rio Arriba, San Juan, Santa Fe, and Socorro.

Coal production of New Mexico in 1910 and 1911, by counties, in short tons—Continued.

1911.

County.	Loaded at mines for shipment.	Sold to local trade and used by employes.	Used at mines for steam and heat.	Made into coke.	Total quantity.	Total value.	Average price per ton.	Average number of days active.	Average number of employees.
Colfax	1,504,323	11,523	14,657	767,108	2,297,611	$3,066,686	$1.33	221	2,848
McKinley	700,675	7,124	23,566		731,365	1,121,621	1.53	262	844
Other counties [a]	103,464	7,843	7,101		118,408	335,955	2.84	226	315
Small mines		774			774	1,663	2.15		
Total	2,308,462	27,264	45,324	767,108	3,148,158	4,525,925	1.44	230	4,007

[a] Lincoln, Rio Arriba, Sandoval, San Juan, Santa Fe, and Socorro.

In the following table are presented the statistics of production, by counties, during the last five years, with increase and decrease in 1911 as compared with 1910:

Coal production of New Mexico, 1907–1911, by counties, in short tons.

County.	1907	1908	1909	1910	1911	Increase (+) or decrease (−), 1911.
Colfax	1,844,550	1,781,635	2,013,318	2,651,585	2,297,611	− 353,974
Lincoln	1,691	1,245	1,466	2,476	1,658	− 818
McKinley	629,821	539,050	665,423	698,730	731,365	+ 32,635
Rio Arriba	34,450	20,000	12,266	10,200	2,625	− 7,575
Santa Fe	31,952	54,740	46,495	73,106	58,726	− 14,380
Other counties and small mines	86,495	71,267	62,160	72,224	56,173	− 16,051
Total	2,628,959	2,467,937	2,801,128	3,508,321	3,148,158	− 360,163
Total value	$3,832,128	$3,368,753	$3,619,744	$4,877,151	$4,525,925	−$351,226

The first record of coal production in New Mexico is that contained in the first volume of Mineral Resources of the United States, published in 1882. In that year the production amounted to 157,092 tons, about one-twentieth of what it is at the present time. The maximum was reached in 1910, when the production of coal in New Mexico was 3,508,321 short tons.

Production of coal in New Mexico from 1882 to 1911, in short tons.

Year.	Quantity.	Year.	Quantity.	Year.	Quantity.	Year.	Quantity.
1882	157,092	1890	375,777	1898	992,288	1906	1,964,713
1883	211,347	1891	462,328	1899	1,050,714	1907	2,628,959
1884	220,557	1892	661,330	1900	1,299,299	1908	2,467,937
1885	306,202	1893	665,094	1901	1,086,546	1909	2,801,128
1886	271,285	1894	597,196	1902	1,048,763	1910	3,508,321
1887	508,034	1895	720,654	1903	1,541,781	1911	3,148,158
1888	626,665	1896	622,626	1904	1,452,325		
1889	486,943	1897	716,981	1905	1,649,933	Total	34,250,976

NORTH CAROLINA.

A small production (120 tons) was reported to the Survey from Moore County, N. C., in 1911, the first output of coal reported from that State since 1905, when the Cumnock mines in Chatham County were permanently closed down.

NORTH DAKOTA.

Total production in 1911, 502,628 short tons; spot value,$720,489.

Lignite production in North Dakota in 1911 made a decided advance over any previous record and amounted for the first time in the history of the State to more than half a million short tons. North Dakota was one of the few Western States whose production in 1911 exceeded that of 1910, whereas in 1910 it had been the one State of the Rocky Mountain and Great Plains provinces that showed a decrease. The production in 1911 exceeded that of 1910 by 103,587 short tons, or 25.96 per cent, in quantity and by $125,350, or 21.06 per cent, in value. Although the total production in the State and the increase in 1911 over 1910 are not of much importance when compared with the output of coal in most of the other States, east or west, both are significant as indicating some success in the efforts to utilize this local fuel resource, low grade as it is, compared with the coals from other States brought into competition with it. The development and utilization of the lignites of North Dakota, as of Texas, must depend upon relatively local markets, for as they disintegrate rapidly upon exposure to the atmosphere they do not bear long distance transportation, and must be used in a short time after being mined. Lignite is not a high-grade fuel, and on account of its large moisture content, does not reach high temperatures in combustion. It is, therefore, undesirable as a steam-raising fuel, though it can be used for that purpose in specially constructed furnaces with large grate areas. It does, however, serve fairly well for a domestic fuel where other coals are obtainable only at a high price. It has also been found, on account of its smokeless and sootless qualities, to be well adapted for burning brick, one of the few manufacturing industries of North Dakota, and considerable quantities are burned each year in brickkilns at Dickinson, Scranton, and Kenmare.

The University of North Dakota has been conducting some interesting experiments on the utilization of lignite for gas making and in the manufacture of briquets. A plant operated by the School of Mines of the University has been located at the mining substation at Hebron. Details regarding that plant are given in the chapter on fuel briquetting.

A bulletin giving a complete description of the plant and of the work proposed to be done was published by the university in 1911.

Lignite, as has been stated, is not a satisfactory steam fuel, but investigations have shown that it is exceedingly well adapted to the manufacture of producer gas, and as the gas producer and the internal combustion engines come into more general use the formerly despised lignites of North Dakota will be found to possess great potentialities in the settlement and upbuilding of the State.

The lignite mines of North Dakota gave employment in 1911 to 640 men, who worked an average of 229 days, against 534 men for 207 days in 1910. The average production per man in the two years was 785.4 tons and 747.3 tons, respectively. The daily production per man was 3.43 tons in 1911, against 3.61 tons in 1910.

Of the total production in 1911, 192,943 short tons, or 38 per cent, were undercut by machines, of which there were 11 of chain-breast type employed. About one-third of the production not machine mined was shot off the solid. Shooting off the solid was the method employed in producing about one-fourth of the State's output. One man killed by an explosion of powder was the only fatal accident in the lignite mines of North Dakota in 1911.

The mines were practically free from labor troubles in 1911, only two interruptions to work for this cause being reported. One of these was settled in 24 hours, the other lasted 3½ days.

The statistics of production, by counties, in 1910 and 1911, with the distribution of the product for consumption, are shown in the following table:

Coal production of North Dakota in 1910 and 1911, by counties, in short tons.

1910.

County.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Total quantity.	Total value.	Average price per ton.	Average number of days active.	Average number of employees.
Burleigh	126,250	9,644	6,703	142,597	$196,889	$1.38	220	177
McLean	1,500	2,490	100	4,090	5,101	1.25	223	6
Morton	....	23,225	25	23,250	24,609	1.06	243	14
Stark	49,500	5,700	1,500	56,700	80,110	1.41	255	64
Ward	87,829	27,917	1,636	117,382	204,149	1.74	180	231
Other counties [a]	3,958	22,813	663	27,434	40,701	1.48	210	42
Small mines	....	27,588	....	27,588	43,580	1.58	....	....
Total	269,037	119,377	10,627	399,041	595,139	1.49	207	534

1911.

County.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Total quantity.	Total value.	Average price per ton.	Average number of days active.	Average number of employees.
Adams	4,027	7,821	12	11,860	$13,873	$1.17	193	18
Burke	7,200	9,160	225	16,585	20,226	1.22	205	18
McLean	1,451	5,182	530	7,163	11,013	1.54	183	7
Morton	3,800	16,224	10	20,034	24,139	1.20	171	35
Stark	52,245	3,542	2,590	58,377	66,067	1.13	270	61
Ward	103,059	33,635	1,411	138,105	241,757	1.75	230	201
Williams	14,200	6,374	342	20,916	27,203	1.30	250	37
Other counties [b]	173,093	24,155	7,778	205,026	279,839	1.36	229	263
Small mines	....	24,562	....	24,562	36,372	1.48	....	....
Total	359,075	130,655	12,898	502,628	720,489	1.43	229	640

[a] Adams, Emmons, Hettinger, Oliver, and Williams.
[b] Burleigh, Divide, Hettinger, Mercer, and Oliver.

The statistics of production, by counties, during the last five years, with increase and decrease in 1911, as compared with 1910, are shown in the following table:

Coal production of North Dakota, 1907–1911, by counties, in short tons.

County.	1907	1908	1909	1910	1911	Increase (+) or decrease (−), 1911.
Burke	....	....	....	....	16,585	+ 16,585
Burleigh	123,662	116,957	122,422	142,597	173,214	+ 30,617
McLean	9,660	7,452	9,325	4,090	7,163	+ 3,073
Morton	10,690	20,850	18,634	23,250	20,034	− 3,216
Stark	71,563	38,467	72,550	56,700	58,377	+ 1,677
Ward	124,214	115,780	139,996	117,382	138,105	+ 20,723
Williams	5,400	13,969	18,722	17,380	20,916	+ 3,536
Other counties and small mines	2,571	7,267	40,398	37,642	68,234	+ 30,592
Total	347,760	320,742	422,047	399,041	502,628	+ 103,587
Total value	$560,199	$522,116	$645,142	$595,139	$720,489	+$125,350

Lignite has doubtless been mined and used in North Dakota by ranchmen and others since the time when the State was a Territory, but it was not until 1884 that any record of production was obtained. This was published in the volume of Mineral Resources of the United States covering that year. The production since 1884 is given in the following table:

Production of coal in North Dakota from 1884 to 1911, in short tons.

Year.	Quantity.	Year.	Quantity.	Year.	Quantity.	Year.	Quantity.
1884	35,000	1892	40,725	1900	129,883	1908	320,742
1885	25,000	1893	49,630	1901	166,601	1909	422,047
1886	25,955	1894	42,015	1902	226,511	1910	399,041
1887	21,470	1895	38,997	1903	278,645	1911	502,628
1888	34,000	1896	78,050	1904	271,928		
1889	28,907	1897	77,246	1905	317,542	Total.	4,428,716
1890	30,000	1898	83,895	1906	305,689		
1891	30,000	1899	98,809	1907	347,760		

OHIO.

Total production in 1911, 30,759,986 short tons; spot value, $31,810,123.

The conditions affecting the coal-mining industry of Ohio in 1911 were in striking contrast to those obtaining in 1910. In 1910, although the influence of the strike extended to the Ohio mines and 24,746 men were idle for an average of 54 days on that account, there was increased activity when mining was resumed and large quantities of Ohio coal were shipped to the markets usually supplied by Illinois and Indiana fuel. The production of the State rose to the high-water mark of 34,209,668 short tons. In 1911 the production fell off to 30,759,986 tons, a decrease of 3,449,682 tons, or 10 per cent. The smaller tonnage was in excess of market requirements, as is evinced by a decrease in the value of $4,122,165, or 11.5 per cent, from $35,932,288 in 1910 to $31,810,123 in 1911, and by a decline from $1.05 to $1.03 in the average price per ton. Production decreased in 19 counties and increased in 8. The increases, with two exceptions, were less than 50,000 tons and none amounted to 150,000 tons, whereas in one county, Athens, the decrease amounted to 1,301,033 tons, in another, Guernsey, it was 791,312 tons, and in a third, Jefferson, it was 553,950 tons.

The principal labor troubles in Ohio during 1911 were in Athens and in Tuscarawas counties. In the former the mines of only four companies were affected and the strikes were of short duration, ranging from 1 to 32 days, with an average of 6 days for the 4,572 men affected. The trouble in Tuscarawas County was largely left over from 1910, some of the mines, when the strike was settled in May, 1911, having been idle for nearly 12 months. The district affected was known as the Tuscarawas-Sherrodsville district, and in it 1,650 men were idle 138 days during 1911. There were 9,530 men on strike at one time or another in the State during the year, the average time lost being 37 days.

The supremacy of Ohio in the percentage of the total production mined by machines, on which comment has been made in earlier reports of this series, was not only maintained but advanced by the record of 1911. The total quantity of coal mined by machines in

Ohio in 1911 was less than in 1910, but the decrease in the production of machine-mined coal was not as great as the decrease in the total production of the State, and the number of machines in use increased from 1,452 in 1910 to 1,536 in 1911. The quantity of machine-mined coal decreased from 28,887,241 short tons in 1910 to 26,556,630 tons in 1911, but the percentage of the machine-mined tonnage to the total increased from 84.44 to 86.33. Ohio sets an excellent example also in the small quantity of coal shot from the solid within the State, which bears tribute to the combined good work of the mine-inspection service of the State and to the mine workers. Out of a total of 30,759,986 short tons, 26,556,630 tons were mined by machines, 2,117,414 tons were mined by hand, and 857,234 tons were shot from the solid. Mines producing 1,228,708 short tons did not report the mining methods employed. The quantity of coal shot from the solid was less than 3 per cent of the total output, a record of which the State may well be proud.

The United States Bureau of Mines reports that there were 109 men killed in and about the coal mines in 1911. The fatalities underground were 109, of which 90 were caused by falls of roof or coal, 12 by mine cars or motors, and 1 by explosions of powder or premature blasts. No deaths were charged to explosions of gas or dust and there were no shaft accidents. One man was killed on the surface. The death rate was 2.37 per thousand against 3.45 in 1910. The quantity of coal mined for each life lost was 282,202 short tons in 1911 and 212,482 tons in 1910.

The statistics of production, by counties, in 1910 and 1911, with the distribution of the product for consumption, are shown in the following table:

Coal production of Ohio in 1910 and 1911, by counties, in short tons.

1910.

County.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Made into coke.	Total quantity.	Total value.	Average price per ton.	Average number of days active.	Average number of employees.
Athens	5,413,707	61,191	113,462	5,200	5,593,560	$6,183,974	$1.11	190	7,406
Belmont	7,981,477	191,793	91,749	....	8,265,019	7,896,992	.96	233	9,360
Carroll	265,985	41,711	5,821	....	313,517	338,223	1.08	191	748
Columbiana	649,929	51,415	13,908	....	715,252	796,558	1.11	254	994
Coshocton	383,694	38,844	4,803	....	427,341	513,498	1.20	223	663
Galiia	6,737	2,450	....	....	9,187	11,182	1.22	71	69
Guernsey	4,578,059	30,775	78,160	....	4,686,994	4,295,136	.92	233	5,023
Harrison	534,063	18,254	8,620	....	560,937	526,983	.94	224	700
Hocking	1,593,127	25,794	16,654	....	1,635,575	1,792,997	1.10	188	2,491
Holmes	482	9,519	156	....	10,157	12,645	1.24	215	21
Jackson	734,688	115,385	28,583	....	878,656	1,423,960	1.62	164	2,224
Jefferson	4,865,624	293,566	81,742	749	5,241,681	5,232,691	1.00	228	6,006
Lawrence	100,739	47,153	676	....	148,568	187,421	1.26	165	425
Mahoning	37,964	21,705	765	....	60,434	95,685	1.58	196	156
Medina	16,488	6,660	1,000	....	24,148	39,314	1.63	179	40
Meigs	552,592	41,424	5,476	....	599,492	716,362	1.19	225	972
Muskingum	158,686	79,350	759	....	238,795	252,135	1.06	120	677
Noble	417,305	5,884	5,375	....	428,564	393,616	.92	245	480
Perry	2,190,291	58,936	34,030	....	2,283,257	2,405,254	1.05	183	3,367
Stark	334,126	139,910	22,473	....	496,509	826,786	1.67	167	1,157
Summit	88,972	3,628	8,643	....	101,243	154,290	1.52	195	189
Tuscarawas	642,690	157,561	15,938	....	816,189	841,333	1.03	115	2,120
Vinton	60,403	23,578	2,820	....	86,801	96,611	1.11	162	186
Wayne	126,756	19,805	12,577	....	159,138	302,477	1.90	151	380
Other counties [a] and small mines	224,401	198,153	6,100	....	428,654	596,165	1.39	130	787
Total	31,958,985	1,684,444	560,290	5,949	34,209,668	35,932,288	1.05	203	46,641

[a] Morgan, Portage, Scioto, and Trumbull.

Coal production of Ohio in 1910 and 1911, by counties, in short tons—Continued.

1911.

County.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Made into coke.	Total quantity.	Total value.	Average price per ton.	Average number of days active.	Average number of employees.
Athens	4,137,664	33,074	121,789	....	4,292,527	$4,655,451	$1.09	144	7,523
Belmont	7,715,763	283,233	93,131	....	8,092,127	7,441,402	.92	201	9,842
Carroll	223,490	42,577	3,100	....	269,167	296,331	1.09	205	452
Columbiana	609,865	37.408	12,923	....	660,196	760,835	1.15	234	1,013
Coshocton	343,092	43,226	4,494	....	390,812	469,328	1.20	198	725
Guernsey	3,801,642	30,081	63,959	....	3,895,682	3,579,661	.92	182	4,988
Harrison	534,072	17,830	7,365	....	559,267	512,187	.92	190	838
Hocking	1,514,973	26,175	34,971	....	1,576,119	1,664,214	1.06	171	2,343
Holmes	200	10,550	180	....	10,930	15,346	1.40	227	32
Jackson	560,690	75,317	33,584	....	669,591	1.185,007	1.77	141	2,043
Jefferson	4,099,181	412,736	175,278	536	4,687,731	4,670.321	.99	194	6,231
Lawrence	26,891	32,011	290	....	59.192	66,270	1.12	159	168
Mahoning	33,525	17,503	1,720	....	52,748	81,966	1.55	182	163
Medina	6,225	7.478	484	....	14.187	23,460	1.65	177	27
Meigs	465,289	42,142	9,414	....	516,845	582,572	1.13	177	1,134
Muskingum	290,712	84,692	1,042	....	376,446	391,133	1.04	196	619
Noble	464,041	5.277	2,685	....	472,003	462,800	.98	210	388
Perry	1,999,356	47,091	40.352	....	2,086,799	2,168,544	1.04	173	3,117
Stark	291,125	137,770	21,361	....	450,256	735,156	1.63	209	885
Summit	72,255	5,985	7,339	....	85,579	148,407	1.73	163	188
Tuscarawas	434,957	227,987	14,386	....	677,330	701.907	1.04	136	1,904
Vinton	34,675	66,313	3,350	....	104,338	113,810	1.09	169	264
Wayne	176,041	15,888	17,130	....	209,059	366,960	1.76	165	480
Other counties *a*	279,010	8.876	12,450	....	300,336	392.719	1.31	165	668
Small mines	....	250.719	....	....	250 719	324.336	1.29	....	....
Total	28.114,734	1,961,939	682,777	536	30,759,986	31,810,123	1.03	179	46,035

a Gallia, Morgan, Portage, and Scioto.

The statistics of production, by counties, during the last five years, with increase and decrease in 1911 as compared with 1910, are shown in the following table:

Coal production of Ohio, 1907–1911, in short tons.

County.	1907	1908	1909	1910	1911	Increase (+) or decrease (−), 1911.
Athens	4.562.694	3,967,318	4,131.270	5,593.560	4,292,527	− 1,301,033
Belmont	6,208,188	5,593,777	6,061,573	8,265,019	8,092,127	− 172,892
Carroll	367,062	366,748	390,273	313,517	269,167	− 44,350
Columbiana	709,515	509,045	657,285	715,252	660,196	− 55,056
Coshocton	403.015	364,028	373,981	427,341	390,812	− 36,529
Gallia	35,195	11,450	7,700	9,187	10,805	+ 1,618
Guernsey	3,970,921	2,939,550	3,085,377	4,686,994	3,895,682	− 791,312
Harrison	499.300	464,676	576,963	560,937	559,267	− 1,670
Hocking	1,648,581	1,434.036	1,194.895	1,635.575	1,576,119	− 59,456
Holmes	22.165	15.009	12,886	10,157	10,930	+ 773
Jackson	1,284.877	836,328	784,463	878,656	669,591	− 209,065
Jefferson	4,528.006	3,591,016	3.908.118	5,241,681	4,687,731	− 553,950
Lawrence	243,027	171,307	184,940	148.568	59,192	− 89.376
Mahoning	94,335	67,312	40.904	60.434	52,748	− 7.686
Medina	46.071	11,407	13.017	24,148	14,187	− 9,961
Meigs	330,503	449.969	564,904	599.492	516.845	− 82,647
Morgan	321,793	268.106	191.391	124,336	174,513	+ 50.177
Muskingum	414,121	430,653	487.179	238.795	376,446	+ 137,651
Perry	2,901,147	2,146,995	2,133,266	2,283,257	2,086,799	− 196,458
Portage	95,462	89,906	100,497	101,826	109.727	+ 7,901
Stark	687,866	501,920	486,272	496,509	450.256	− 46,253
Summit	104.236	98,641	84.872	101,243	85,579	− 15,664
Trumbull	1,000	1,000	620	700	....	− 700
Tuscarawas	1,797,399	1,358,129	1,577,303	816,189	677,330	− 138,859
Vinton	254,529	138,545	151.954	86,801	104,338	+ 17,537
Wayne	185,260	96,431	101,050	159,138	209,059	+ 49,921
Noble Scioto	314,761	208,899	381,327	438,398	477,294	+ 38,896
Small mines	*a* 111,390	138,438	255,361	191,958	250.719	+ 58,761
Total	32,142,419	26,270,639	27,939,641	34,209,668	30,759,986	− 3,449,682
Total value	$35,324,746	$27,897,704	$27,789,010	$35,932,288	$31,810,123	−$4,122,165

a Includes production of Monroe County.

One of the early reports published by Ohio states that in 1838 there were 119,952 short tons produced from the coal mines of the State. It is probable that some coal was mined in Ohio prior to that date, but we have no record of such production. The United States census of 1840 credited Ohio with an output of 140,536 tons. The census of 1850 did not consider the coal-mining industry, and the next report we have of coal production in the State was that of the census of 1860, which recorded an output of 1,265,600 short tons.

A statement of the annual production of coal in Ohio from 1838 to the close of 1911 will be found in the following table:

Production of coal in Ohio from 1838 to 1911, in short tons.

Year.	Quantity.	Year.	Quantity.	Year.	Quantity.	Year.	Quantity.
1838	119,952	1857	975,000	1876	3,500,000	1895	13,355,806
1839	125,000	1858	1,000,000	1877	5,250,000	1896	12,875,202
1840	140,536	1859	1,060,000	1878	5,500,000	1897	12,196,942
1841	160,000	1860	1,265,600	1879	6,000,000	1898	14,516,867
1842	225,000	1861	1,150,000	1880	6,008,595	1899	16,500,270
1843	280,000	1862	1,200,000	1881	9,240,000	1900	18,988,150
1844	340,000	1863	1,204,581	1882	9,450,000	1901	20,943,807
1845	390,000	1864	1,815,622	1883	8,229,429	1902	23,519,894
1846	420,000	1865	1,536,218	1884	7,640,062	1903	24,838,103
1847	480,000	1866	1,887,424	1885	7,816,179	1904	24,400,220
1848	540,000	1867	2,092,334	1886	8,435,211	1905	25,552,950
1849	600,000	1868	2,475,844	1887	10,300,708	1906	27,731,640
1850	640,000	1869	2,461,986	1888	10,910,951	1907	32,142,419
1851	670,000	1870	2,527,285	1889	9,976,787	1908	26,270,639
1852	700,000	1871	4,000,000	1890	11,494,506	1909	27,939,641
1853	760,000	1872	5,315,294	1891	12,868,683	1910	34,209,668
1854	800,000	1873	4,550,028	1892	13,562,927	1911	30,759,986
1855	890,000	1874	3,267,585	1893	13,253,646		
1856	930,000	1875	4,864,259	1894	11,909,856	Total.	611,949,292

OKLAHOMA.

Total production in 1911, 3,074,242 short tons; spot value, $6,291,494.

The coal production of Oklahoma increased from 2,646,226 short tons, valued at $5,867,947, in 1910, to 3,074,242 tons, valued at $6,291,494, in 1911, but although this represented a gain of 428,016 tons, or 16.17 per cent, in quantity and of $423,547, or 7.22 per cent, in value, it did not equal the tonnage mined in either 1909 or 1907. In fact, the output in 1911 was less than the average production of the preceding eight years by more than 10,000 tons. Although the increase in 1911 indicates, therefore, a recovery from the immediate effects of the strike of 1910, it does not show any encouraging growth. It emphasizes, on the contrary, what has already been stated in the discussion of the industry in Arkansas, namely, that the competition of fuel oil and natural gas from the Louisiana and the Mid-Continent fields and of coal from Illinois, Alabama, Kentucky, Colorado, and New Mexico, where mining conditions are more favorable, has restricted the markets for the product of Arkansas and Oklahoma to comparatively narrow limits. Mining rates are, it is claimed, higher than those in the other States mentioned, but even with the higher rates the miners are probably not any better off in the long run because of the fewer number of days they are able to work.

In Arkansas the average number of days worked in 1911 was 133, in Oklahoma the average was 156; for the two States it was 147 for the

14,447 men employed, barely one-half of the possible working time and about three-fourths of the average time made by all of the coal-mine workers in each of the last five years.

The average price per ton for Oklahoma coal declined from $2.22 in 1910, when values were naturally advanced because of the strike, to $2.05 in 1911. The latter figure, although 5 cents above the average for 1909 and higher than in any recent year except 1910, probably effects little if any net increase to the operators, as the miners in Oklahoma participated in the advance in wages following the strike of the previous year.

One of the laws enacted by the first legislature of the new State of Oklahoma provided that all coal mined in the State should be paid for on the mine-run basis. This enactment, it is claimed, has encouraged the practice of shooting the coal from the solid—of "making the powder do the work"—a practice which all authorities agree is wasteful of the coal in that it produces an unnecessary quantity of small and unsalable coal and lowers the quality of the entire product. More serious than this, however, is the added danger to life and property which increases the sufficiently hazardous character of the coal miner's occupation. The quantity of coal mined by machines in Oklahoma is relatively small (87,048 tons in 1911), and only a small percentage of the coal is properly mined either by hand or machine. In 1911, out of a total of 2,678,557 tons for which the mining methods were reported, only 255,250 tons, or 9.5 per cent, were really "mined." The quantity shot off the solid was 2,423,307 tons, or 90.5 per cent.

The reports of accidents to the United States Bureau of Mines show that 33 men were killed in the coal mines of Oklahoma during 1911. The death rate per 1,000 employees was 3.75 and the number of tons mined for each life lost was 93,159.

The number of men employed in the coal mines of Oklahoma in 1911 was 8,790, who worked an average of 156 days, as compared with 8,657 men for 144 days in 1910. Only once in recent years have the mine workers been able to work more than 200 days in the year. The exception was in the boom year, 1907. In no other year since 1905 have the mines worked more than an average of 190 days, whereas in only one year (1908) has the general average for the United States fallen below 200 days. This unfavorable comparison is further emphasized by the low tonnage rate per employee. In 1911 the average daily production by each man employed was 2.24 tons, and as the average working time was only 156 days, the average production per man for the year was 350 tons. In 1910 the average production per man was 306 tons for the year and 2.13 tons for each working day. All of these averages are below most of the States and considerably lower than the mean averages for all of the States.

The statistics of production in 1910 and 1911, by counties, are shown in the following table:

Coal production of Oklahoma in 1910 and 1911, by counties, in short tons.

1910.

County.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Made into coke.	Total quantity.	Total value.	Average price per ton.	Average number of days active.	Average number of employees.
Coal	469,062	8,390	21,206	....	498.658	$1,071,644	$2.15	145	2,000
Haskell and Latimer	617,815	3,336	49.031	5.771	675.953	1,360,978	2.01	165	1,868
Le Flore	80.289	1,327	6,012	....	87.628	139,351	1.59	111	293
Okmulgee	212,858	9,318	4.931	....	227.107	441.110	1.94	143	619
Pittsburg	989.576	21,502	72.165	....	1,083,243	2.672.582	2.47	134	3.752
Other counties[a]	66,387	936	302	....	67.625	164.934	2.44	203	125
Small mines	....	6.012	....	....	6.012	17,348	2.89	....	....
Total	2,435,987	50.821	153,647	5.771	2,646,226	5,867,947	2.22	144	8,657

1911.

County.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Made into coke.	Total quantity.	Total value.	Average price per ton.	Average number of days active.	Average number of employees.
Coal	739.586	7,899	31,061	....	778,546	$1,604,611	$2.06	201	1.706
Haskell and Latimer	642.008	4,504	54,862	....	701,374	1,290.196	1.84	155	1.755
Le Flore	112,835	2.774	6,859	....	122.468	182.342	1.49	111	375
Okmulgee	391,811	6,461	9.930	....	408.202	693.938	1.70	157	1,166
Pittsburg	915.635	19,153	83,954	....	1,018.742	2,424.763	2.38	140	3.660
Tulsa	20,893	404	125	....	21,422	46,324	2.16	131	75
Other counties[b]	17,234	2.207	175	....	19.616	38.729	1.97	172	53
Small mines	....	3,872	....	....	3.872	10.591	2.74	....	....
Total	2,840,002	47.274	186,966	....	3,074.242	6.291.494	2.05	156	8,790

[a] Rogers, Tulsa, and Wagoner.

[b] Atoka, Johnston, Rogers, and Wagoner.

The year 1908 was the first for which it was possible to give the production of Oklahoma (formerly Indian Territory) by counties, it having been organized as a State and admitted into the Union in 1906. The production by counties in 1908, 1909, 1910, and 1911, with increase and decrease in 1911 compared with 1910, is shown in the following table:

Coal production of Oklahoma in 1908, 1909, 1910, and 1911, by counties, in short tons.

County.	1908	1909	1910	1911	Increase(+) or decrease (—), 1911.
Coal	576,746	658,159	498.658	778,546	+279.888
Haskell and Latimer	674,636	738,806	675.953	701.374	+ 25,421
Le Flore	187,624	128.376	87,628	122.468	+ 34.840
Okmulgee	172,934	262.310	227,107	408,202	+ 181,095
Pittsburg	1,294.936	1,271,109	1,083,243	1,018,742	— 64.501
Rogers and Wagoner	....	14.556	27,618	18.784	— 8,834
Tulsa	39.848	39,834	40.007	21.422	— 18.585
Small mines	1,392	6,227	6.012	[a] 4.704	— 1,308
Total	2.948.116	3,119,377	2,646.226	3,074,242	+ 428.016
Total value	$5.976.504	$6,253,367	$5,867,947	$6,291.494	+$423,547

[a] Includes Atoka and Johnston counties.

The Tenth United States Census (1880) contains the first published record of coal production in Oklahoma (Indian Territory), although as a small quantity of coal was mined in Arkansas as early as 1840, it is probable that some was produced in the Territory earlier than 1880. The maximum production, 3,642,658 short tons, was obtained in the boom year 1907, but as shown in the following table the industry during the last nine years has been practically stationary and has not shown the development and progress exhibited in other States:

Production of coal in Oklahoma from 1880 to 1911, in short tons.

Year.	Quantity.	Year.	Quantity.	Year.	Quantity.	Year.	Quantity.
1880	120,947	1889	752,832	1898	1,381,466	1907	3,642,658
1881	150,000	1890	869,229	1899	1,537,427	1908	2,948,116
1882	200,000	1891	1,091,032	1900	1,922,298	1909	3,119,377
1883	350,000	1892	1,192,721	1901	2,421,781	1910	2,646,226
1884	425,000	1893	1,252,110	1902	2,820,666	1911	3,074,242
1885	500,000	1894	969,606	1903	3,517,388		
1886	534,580	1895	1,211,185	1904	3,046,539	Total.	51,632,976
1887	685,911	1896	1,366,646	1905	2,924,427		
1888	761,986	1897	1,336,380	1906	2,860,200		

OREGON.

Total production in 1911, 46,661 short tons; spot value, $108,033.

The coal production of Oregon in 1911 was the smallest in nearly two decades, or since 1893. All of the production is from the lignite areas in Coos County, which, surrounding as they do the shores of Coos Bay, have easy and cheap transportation to San Francisco, the principal market. The industry which has never been of much importance, has suffered in recent years from the increased use of petroleum from the California wells. Compared with 1910, the production in 1911 showed a decrease of 20,872 tons, or 30.9 per cent, in quantity, and of $127,196, or 54 per cent, in value.

The statistics of production in Oregon, with the distribution of the product for consumption during the last five years, are shown in the following table:

Distribution of coal production of Oregon, 1907–1911, in short tons.

Year.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Total quantity.	Total value.	Average price per ton.	Average number of days worked.	Average number of employees.
1907	39,095	14,840	17,046	70,981	$166,304	$2.34	231	184
1908	45,375	22,518	18,366	86,259	236,021	2.74	249	214
1909	44,236	25,700	17,340	87,276	235,085	2.69	....	235
1910	40,497	13,583	13,453	67,533	235,229	3.48	257	153
1911	22,407	10,216	14,038	46,661	108,033	2.32	179	189

Coal was first noted in the Coos Bay region about 50 years ago, Prof. J. S. Newberry having reported in 1855 that the coal deposits of Coos Bay had begun to attract attention.

The first cargo was shipped from the Empire Basin, but the discovery of coal near the head of Coos Bay soon transferred the point of production to Newport which remained the principal mine until within the last decade, since the Beaver Hill mine has been more successfully managed and become the chief producer. The first record of coal production is contained in the census report of 1880, when 43,205 short tons were mined. The production has exceeded

100,000 tons in four years only—1896, 1897, 1904, and 1905—the maximum being obtained in 1904, when it reached 111,540 tons. The total production to the close of 1911 has amounted to 2,078,021 short tons, as is shown in the following table:

Production of coal in Oregon, 1880–1911, in short tons.

Year.	Quantity.	Year.	Quantity.	Year.	Quantity.	Year.	Quantity.
1880	43,205	1889	64,359	1898	58,184	1907	70,981
1881	33,600	1890	61,514	1899	86,888	1908	86,259
1882	35,000	1891	51,826	1900	58,864	1909	87,276
1883	40,000	1892	34,661	1901	69,011	1910	67,533
1884	45,000	1893	41,683	1902	65,648	1911	46,661
1885	50,000	1894	47,521	1903	91,144		
1886	45,000	1895	73,685	1904	111,540	Total	2,078,121
1887	37,696	1896	101,721	1905	109,641		
1888	75,000	1897	107,289	1906	79,731		

PENNSYLVANIA.

Total production in 1911, 235,218,230 short tons; spot value, $321,537,250.

Anthracite.—To total production in 1911, 80,771,488 long tons (equivalent to 90,464,067 short tons); spot value, $175,189,392.

Bituminous.—Total production in 1911, 144,754,163 short tons; spot value, $146,347,858.

The combined production of anthracite and bituminous coal in Pennsylvania in 1911 exceeded that of 1910 by 211,468 short tons, or 0.09 per cent, in quantity and by $8,232,438, or 2.63 per cent, in value. The reason for the larger proportionate gain in value was the increased production of the higher-priced anthracite, whereas the production of bituminous coal decreased. The output of anthracite increased 5,338,242 long tons, or 5,978,831 short tons, in quantity and $14,914,090 in value, while that of bituminous coal decreased in quantity (nearly all of the decrease being in the coal made into coke) almost as much as anthracite had increased, or 5,767,363 short tons. The decrease in the value of the bituminous production was $6,681,652. Notwithstanding the increase in anthracite and the decrease in bituminous coal production in 1911, the output of the latter exceeded the former by 54,290,096 short tons, but the value of the anthracite exceeded that of the bituminous production by $28,841,534, or 19.7 per cent. Pennsylvania's coal production, anthracite and bituminous combined, exceeds that of any other country of the world except Great Britain and Germany, and is closely rivalling the latter. Pennsylvania's production of coal is more than four times that of Austria-Hungary, the third producing country of the world; more than five times that of France; more than eight times that of Belgium; and is equal to nearly one-fifth of the total world's production. From 1829 to and including the first year of the present century Pennsylvania contributed over 50 per cent of the total coal production of the United States and still produces between 45 and 50 per cent of the total, but the relative importance of Pennsylvania as a coal producer has steadily declined in recent years. Whereas in 1880 Pennsylvania produced 66 per cent of the total; in 1890 its percentage was 56; in 1900 it was 51; in 1910 it was 46.9; and in 1911 it was 47.4. The smaller percentage in the later years as compared with the earlier must not be taken as an indication of any decline in the coal-mining industry of Pennsylvania, for that industry has, particularly in the bituminous districts, kept pace with the manufacturing industries and has increased in considerably larger ratio than the population of the State and of the United States as a whole. The falling off in the relative importance of Pennsylvania has been due to the more rapid increase in the production of other States, notably of West Virginia, Illinois, Alabama, and the Rocky Mountain States.

The following table shows the total production of the United States and of Pennsylvania since 1880, with the percentage of the total tonnage produced by Pennsylvania in each year:

Production of Pennsylvania coal compared with total production of the United States, 1880–1911, in short tons.

Year.	Total United States.	Pennsylvania.	Percentage of Pennsylvania to total.	Year.	Total United States.	Pennsylvania.	Percentage of Pennsylvania to total.
1880	71,481,570	47,074,975	66	1896	191,986,357	103,903,534	54
1881	85,881,030	54,320,018	63	1897	200,223,665	107,029,654	53
1882	103,285,789	57,254,507	55	1898	219,976,267	118,547,777	54
1883	115,212,125	62,488,190	54	1899	253,741,192	134,568,180	53
1884	119,735,051	62,404,488	52	1900	269,684,027	137,210,241	51
1885	110,957,522	62,137,271	56	1901	293,299,816	149,777,613	51
1886	112,743,403	62,857,210	56	1902	301,590,439	139,947,962	46
1887	129,975,557	70,372,857	54	1903	357,356,416	177,724,246	49.7
1888	148,659,402	77,719,624	52	1904	351,816,398	171,094,996	49
1889	141,229,514	81,719,059	58	1905	392,722,635	196,073,487	49.9
1890	157,770,963	88,770,814	56	1906	414,157,278	200,575,617	48.4
1891	168,566,668	93,453,921	55	1907	480,363,424	235,747,489	49.1
1892	179,329,071	99,167,080	55	1908	415,842,698	200,448,281	48.2
1893	182,352,774	98,038,267	54	1909	460,814,616	219,037,150	47.5
1894	170,741,526	91,833,584	54	1910	501,596,378	235,006,762	46.9
1895	193,117,530	108,216,565	56	1911	496,188,308	235,185,370	47.4

The total number of men employed in the coal mines of Pennsylvania in 1911 was 340,859, of whom 172,585 were engaged in the mining of anthracite and 168,274 in the mining of bituminous coal. The anthracite mines were operated an average of 246 days during the year and the bituminous mines were worked an average of 233 days. In 1910 the anthracite mines gave employment to 169,497 men, who worked an average of 229 days, and the bituminous mines employed 175,403 men, who worked an average of 238 days. The total number of men employed in the mines of Pennsylvania in 1910 was 344,900.

The number of men employed and the average number of days worked being considered, the total days worked in the anthracite region was about 10 per cent more than in the bituminous regions, although the bituminous production exceeded that of the anthracite by 60 per cent. The average yearly production per man in the anthracite region in 1911 was 524 tons, and it was 738 tons in the bituminous fields.

In previous reports of this series reference has been made to the rapid increase in the production of bituminous coal, compared with that of anthracite. The increase in the production of anthracite bears an approximate relation to the increase in population. This has been particularly marked during the last two decades, or since the use of anthracite for iron making and in other branches of manufacture has practically disappeared.

Its use is now confined principally to domestic consumption and to the heating of hotels, apartment houses, and large office buildings. The natural sequence is that its increase in production should be regulated by the increase in population. Bituminous production, on the other hand, has owed its gain to the rapid development of the United States as a manufacturing country, and the record of bituminous coal production may be taken as indicating the progress made in manufactures.

The following table shows the average production of Pennsylvania anthracite and of bituminous coal in the United States, by five-year periods, from 1876 to 1910, and for the one year, 1911, with the percentage that each bears to the total. It will be observed from this table that the average annual production of anthracite during the last five years of this period (1906 to 1910) was 3.1 times the average yearly production from 1876 to 1880. The production of anthracite in 1911 was something more than double that of the average production from 1886 to 1890. The average annual bituminous tonnage in the five years from 1906 to 1910 was 10.2 times that of the first five years, and the production in 1911 was more than four times that of the average from 1886 to 1890. From 1876 to 1880 anthracite production represented 41.44 per cent of the total, and bituminous coal 58.56 per cent. From 1906 to 1910 the anthracite production averaged 17.85 per cent of the total, and bituminous coal 82.15 per cent. On account of the decreased production of bituminous coal in 1911 and the increase in the output of anthracite, the percentage to the total of the latter showed a slight gain to 18.2 per cent for that year, while the percentage of bituminous production declined to 81.8 per cent of the total.

Production of anthracite and bituminous coal since 1876, by averages of five-year periods, in short tons.

Period.	Anthracite.		Bituminous.	
	Quantity.	Percentage of total.	Quantity.	Percentage of total.
1876–1880	25,800,169	41.44	36,460,776	58.56
1881–1885	36,198,188	33.74	71,092,930	66.26
1886–1890	43,951,763	31.76	94,446,451	68.24
1891–1895	53,405,187	29.87	125,416,327	70.13
1896–1900	55,625,265	24.49	171,498,143	75.51
1901–1905	66,853,778	19.70	272,503,363	80.30
1906–1910	81,142,214	17.85	373,412,644	82.15
1911	90,464,067	18.2	405,724,241	81.8

Anthracite mining began in Pennsylvania in 1814, when 20 long tons were produced for local consumption. The year 1820 is, however, usually considered to mark the beginning of the anthracite industry, as in that year 365 long tons were shipped from the anthracite region. From 1814 to the close of 1911 the total production of anthracite had amounted to 2,027,498,872 long tons, or 2,270,798,737 short tons.

The first records of bituminous-coal production in Pennsylvania are for the year 1840, when 464,826 short tons were mined. The total output of bituminous coal from 1840 to the close of 1911 has amounted to 2,396,491,260 short tons, from which it appears that the total production of anthracite and of bituminous coal in Pennsylvania has been nearly equal. At the close of 1908 the total production of anthracite from the earliest times to the close of that year had exceeded the total bituminous production by approximately 51,000,000 tons. As, however, the production of bituminous coal in 1910 and 1911 exceeded that of anthracite by more than 120,000,000 short tons, the total production of bituminous coal now exceeds that of anthracite.

PENNSYLVANIA ANTHRACITE.

The production of anthracite in Pennsylvania in 1911 reached the highest point in the history of the industry, exceeding the previous maximum record of 1907 by 4,300,000 long tons. The quantity of anthracite produced in 1911 was 80,771,488 long tons, valued at $175,189,392. In 1910 the output amounted to 75,433,246 tons, valued at $160,275,302, indicating an increase in 1911 of 5,338,242 long tons, or 7 per cent, in quantity, and of $14,914,090, or 9 per cent, in value. In this increased activity and augmented production in 1911 the anthracite industry was in marked contrast to the bituminous industry, which showed decreases throughout most of the mining regions. The principal exceptions to decreased tonnage in the bituminous-producing States were in Illinois, Missouri, Arkansas, Kansas, and Oklahoma, most of whose mines were closed by the prolonged strike of 1910. Moreover, throughout most of the bituminous districts prices were generally demoralized, whereas the average price for anthracite in 1911 was 5 cents higher than in 1910. This does not mean, however, that there was a general advance of prices for anthracite in 1911. The prices for the domestic sizes above pea coal in 1911 were the same as in 1910; but the proportion of the larger and higher-priced sizes sent to market in 1911 was greater than in either 1910 or 1909, and the quantity of cheaper coal recovered by washeries was less in 1911 than in any of the preceding five years. The demand for chestnut coal, which is the smallest of the domestic or profitable sizes, is reported to have increased somewhat more in proportion than that for the prepared sizes above pea, and an advance of 25 cents was made on that size in the later part of 1910, continuing through 1911. Prices for the other domestic sizes, furnace, egg, and stove, were the same in 1911 as in 1910. The average price for anthracite in 1911 was $2.17 per long ton, against $2.12 in 1910, $2.06 in 1909, and $2.13 in 1908.

The increased production of anthracite in 1911 was probably due, in part at least, to an activity in the later part of the year, stimulated by the anticipation of and to make provision for an expected suspension of mining when the third three-year period of wage agreements should terminate, on March 31, 1912. How much of such coal went into storage has not been reported, but it is certain that the unusually if not unprecedentedly severe winter of 1911–12 necessitated the practical exhaustion of such storage coal before the suspension took place.

Of the total production of 80,771,488 long tons in 1911, 70,441,597 long tons, or 87.2 per cent, were loaded at the mines for shipment to distant points; 2,050,403 tons, or 2.5 per cent, were used by employees or sold to immediately local trade; and 8,279,488 tons, or 10.3 per cent, were consumed in the operation of the collieries. In former years, although the quantity of coal consumed at the mines was included in the production, no value was placed on it, as it consisted of culm, for which no market existed, and which, if not used at the mines, was thrown on the culm bank as waste. Nowadays there is a demand for almost any grade of anthracite that will burn, and the culm banks are contributing their share to the total production in the fuel recovered from them by washeries, the waste from some of the washeries being flushed back into the mines, where in time it cements together, furnishes support to the roof, and enables a further recovery of coal from the pillars which the agglomerated waste replaces.

The recovery from the culm banks and the small sizes obtained from the freshly mined coal constitute over 40 per cent of the total quantity of anthracite sent to market. In 1911 out of total shipments amounting to 70,424,197 long tons, 41,728,071 long tons, or 59.2 per cent, were of sizes above pea coal, and 28,696,126 long tons, or 40.8 per cent, were pea and smaller. The price of pea coal at the mines is very close to actual cost, and the sizes below pea—buckwheat No. 1, buckwheat No. 2, or rice, and buckwheat No. 3, or barley—are sold below the cost of production, the prices for these sizes in 1911 being, respectively, $1.60, $1.43, and $1.13. The production of buckwheat No. 1 was 9,836,638 long tons; of buckwheat No. 2, 6,239,134 tons; and of buckwheat No. 3, 3,924,467 tons. "Screenings" to the amount of 413,838 tons were also included in the production. The total production of sizes below pea was 20,414,077 long tons.

The United States Bureau of Mines reports that there were 710 fatal accidents in the anthracite mines in 1911, against 601 in 1910. The principal causes in 1911 were: Falls of roof and coal, 282; haulage accidents, 97; gas explosions, 30; powder explosions, 80; shaft and surface accidents, 111; miscellaneous, 110.

In the report for 1910 attention was directed to the effect produced on the working time of the anthracite mine workers by the policy of the operators, adopted several years ago, of allowing discounts from the circular prices for coal purchased during the summer months. The discounts allowed are 50 cents a ton in April, 40 cents in May, 30 cents in June, 20 cents in July, and 10 cents in August. This inducement to make the cellars of consumers the storage places for winter supplies has given steadier employment to the mine workers and has undoubtedly contributed largely to the prosperous condition that has had place in the anthracite region during the last decade. The statement made in the report for 1910 is repeated here—that from 1897 to 1901, before the policy was adopted, the average number of days worked in the anthracite mines ranged from 150 to 196, with a mean average of 165 days. From 1906 to 1910 the average number of working days ranged from 195 to 229, with a mean average of 210 days. In 1911 the average number of working days was 246, the largest average ever recorded, and an increase of 50 per cent over the average for the five years from 1897 to 1901, inclusive. There were 172,585 men employed in the anthracite mines in 1911 against 169,497 in 1910. The average production by each man was 445 long tons in 1910 and 468 tons in 1911. The average daily production per man was 1.94 tons in 1910 and 1.9 tons in 1911.

The statistics of anthracite production during the last five years are presented in the table following:

Statistics of anthracite production, 1907–1911.

Year.	Quantity (long tons).	Value.	Average price per ton.	Average number of men employed.	Average number of days worked.
1907	76,432,421	$163,584,056	$2.14	167,234	220
1908	74,347,102	158,178,849	2.13	174,174	200
1909	72,384,249	149,181,587	2.06	[a]171,195 [b]166,801	205
1910	75,433,246	160,275,302	2.12	169,497	229
1911	80,771,488	174,952,415	2.17	172,585	246

[a] State mining department figures.

[b] U. S. census figures.

As shown in the foregoing table, the average price of anthracite in 1911 was higher than in any year since 1907. In fact, the average price in 1911 was higher than in any year since 1887, with the exception of 1903 (colliery consumption considered), and was due, as has already been stated, to the slight increase in the proportion of the prepared sizes and to an arbitrary advance in the price of chestnut coal in order to equalize the demand. The fluctuations in the average price of anthracite are apt to be due to more or fewer sales of certain sizes rather than to any variation in the price of those sizes.

Prior to 1907 no account was taken, in the valuation of the product, of the coal used at the mines for steam and heat, but as every size, even the dust, is now a marketable product, it has been thought advisable to put an arbitrary value on such coal. In 1907 and 1908 the colliery consumption was valued at 20 cents a ton. In 1909, 1910, and 1911 it was reported by the operators as of the same value as similar coal put on the market.

The production, by counties, in 1910 and 1911, with the distribution of the product for consumption, is shown in the table following:

Anthracite production in 1910 and 1911, by counties, in long tons.

1910.

County.	Shipped.	Sold to local trade and employees.	Used at mines for steam and heat.	Total.
Carbon	2,438,321	64,800	299,734	2,802,855
Columbia	728,370	12,837	104,141	845,348
Dauphin	602,948	55,931	132,364	791,243
Lackawanna	17,390,927	453,670	1,721,768	19,566,365
Luzerne	24,886,361	732,449	2,928,993	28,547,803
Northumberland	4,960,463	119,408	633,398	5,713,269
Schuylkill	13,678,396	279,137	1,986,641	15,944,174
Sullivan	518,889	6,898	39,175	564,962
Susquehanna	508,086	9,935	47,373	565,394
River dredges	22,263	69,017	553	91,833
Total	65,735,024	1,804,082	7,894,140	75,433,246

Anthracite production in 1910 and 1911, by counties, in long tons—Continued.

1911.

County.	Shipped.	Sold to local trade and employees.	Used at mines for steam and heat.	Total.
Carbon	2,512,675	87,986	346,113	2,946,774
Columbia	918,828	11,165	135,843	1,065,836
Dauphin	651,664	51,525	142,316	845,505
Lackawanna	18,911,259	618,619	1,699,265	21,229,143
Luzerne	26,393,558	772,728	3,076,588	30,242,874
Northumberland	5,467,363	110,699	649,657	6,227,719
Schuylkill	14,427,485	304,026	2,138,081	16,869,592
Sullivan	590,396	7,203	42,963	640,562
Susquehanna	550,969	9,809	48,058	608,836
River dredges	17,400	76,643	604	94,647
Total	70,441,597	2,050,403	8,279,488	80,771,488

The following table shows the shipments, by months, during the last five years, as reported by the State bureau of anthracite statistics. The table does not include the shipments from Sullivan County nor the shipments of coal recovered from Susquehanna River.

Monthly shipments of anthracite, 1907–1911, in long tons.

Month.	1907	1908	1909	1910	1911
January	5,249,946	5,618,339	5,183,345	5,306,618	5,904,117
February	4,563,720	4,503,756	4,576,004	5,031,784	5,070,948
March	5,235,814	4,766,158	6,332,474	5,174,166	5,996,894
April	5,916,583	5,987,221	5,891,176	6,224,396	5,804,915
May	5,994,272	6,088,116	5,063,873	5,679,661	6,317,352
June	5,976,906	5,704,852	4,904,858	5,398,123	6,215,357
July	5,669,024	4,541,506	4,020,765	4,202,059	4,804,065
August	5,795,347	4,599,093	4,198,273	4,996,044	5,531,796
September	5,512,717	5,211,047	4,116,120	4,967,516	5,730,935
October	6,108,065	5,977,497	5,579,759	5,622,095	6,269,179
November	5,743,522	5,839,491	6,027,800	6,071,746	6,193,314
December	5,343,477	5,827,938	5,775,438	6,231,578	6,115,427
Total	67,109,393	64,665,014	61,969,885	64,905,786	69,954,299

The statistics for the last three or four years indicate that the disproportionate increase in the consumption of the smaller and unprofitable sizes has about terminated, and the probability is that the present ratio of the domestic or prepared sizes and the small or steam sizes will remain fairly steady. From 1890 to 1907 there was a marked increase in the output of steam sizes as compared with the production of the prepared or domestic sizes, as shown by the fact that in the earlier years the shipments of anthracite represented by the sizes above pea coal were 76.9 per cent of the total and that 23.1 per cent was made up of pea coal and smaller. In 1907 the percentage of the sizes above pea coal had fallen to 58.6 and that of pea coal and smaller had increased to 41.4 per cent.

A considerable portion of this increase in the consumption of small sizes has been due to the operation of the washeries in recovering the usable fuel from the old culm banks in the anthracite region. The first washery was installed in 1890, and 41,600 long tons of coal thus recovered were shipped in that year. In 1907 this recovery had increased to 4,301,082 tons. About the time that washeries were introduced to recover this small coal from the culm banks they were also installed at the breakers, with the result that the small sizes, instead of being thrown upon the culm banks, were added to the daily production. In the following table the shipments (not production) of anthracite are given for 1890, 1910, and 1911, exclusive of the washery product obtained from the old culm banks:

Shipments of anthracite, excluding washery product, by sizes, 1890, 1910, and 1911, in long tons.

Year.	Sizes above pea.		Pea and smaller.		Total shipments.
	Quantity.	Percentage.	Quantity.	Percentage.	
1890	28,154,678	76.98	8,419,181	23.02	36,573,859
1910	38,387,111	61.5	24,029,332	38.5	62,416,443
1911	41,667,415	62.0	25,585,104	38.0	67,252,519

The figures showing the washery product are not absolutely exact, for the reason that a few washeries are operated at the mines, the small sizes of the freshly mined coal being washed to remove the slate, and no separate report of the coal so washed is made by the mining companies. "Washery coal" as here reported is for the most part that which is recovered from the old culm banks.

To illustrate the change in the proportion of domestic and steam sizes since 1890, the following table is appended:

Shipments of anthracite, according to sizes, 1890–1911, in long tons.

Year.	Sizes above pea.		Pea and smaller.		Total shipments.
	Quantity.	Percentage.	Quantity.	Percentage.	
1890	28,154,678	76.9	8,460,781	23.1	36,615,459
1891	30,604,566	75.7	9,843,770	24.3	40,448.336
1892	31,868,278	76.0	10.025,042	24.0	41,893,320
1893	32,294,233	74.9	10,795,304	25.1	43,089,537
1894	30,482,203	73.7	10,908,997	26.3	41,391,200
1895	32,469,367	69.9	14,042,110	30.1	46,511,477
1896	30,354,797	70.3	12,822,688	29.7	43,177,485
1897	28,510,370	68.5	13,127,494	31.5	41,637,864
1898	28,198,532	67.3	13,701,219	32.7	41,899,751
1899	31,506.700	66.1	16,158,504	33.9	47,665,204
1900	29,162,459	64.7	15,945,025	35.3	45,107,484
1901	34,412,974	64.2	19,155,627	35.8	53,568.601
1902	19,025,632	61.0	12,175,258	39.0	31,200.890
1903	37,738,510	63.6	21,624,321	36.4	59,362.831
1904	35,636,661	62.0	21,855,861	38.0	57,492.522
1905	37,425,217	60.9	23,984,984	39.1	61,410,201
1906	32,894,124	59.1	22,804,471	40.9	55,698,595
1907	39,332,855	58.6	27,776,538	41.4	67,109.393
1908	38,319,325	59.3	26,345,689	40.7	64,665,014
1909	36,437,762	58.1	[a]26,250.597	41.9	[a]62,688.359
1910	38,415,323	58.5	[a]27,297,438	41.5	[a]65,712,761
1911	41,728,071	59.2	[a]28,696,126	40.8	[a]70,424,197

[a] Exclusive of coal recovered by river dredges.

It should be noted in connection with the division of sizes that pea coal, which was for years a steam coal, is now used extensively for domestic purposes, and though it is impossible to tell what proportion is so used, the fact that it is no longer an exclusively steam size must be taken into consideration in drawing deductions from the figures presented.

To present statistically the comments made on size division, washery production, etc., the following table, showing washery production since 1890, is given:

Shipments of anthracite from washeries and total shipments, 1890–1911, in long tons.

Year.	Shipments from washeries.	Total shipments.	Percentage of washery output to total shipments.
1890	41,600	36,615,459	0.11
1891	85,702	40,448,336	.21
1892	90,495	41,893,320	.22
1893	245,175	43,089,537	.57
1894	634,116	41,391,200	1.53
1895	1,080,800	46,511,477	2.52
1896	895,042	43,177,485	2.07
1897	993,603	41,637,864	2.39
1898	1,099,019	41,899,751	2.62
1899	1,368,275	47,665,204	2.87
1900	2,059,349	45,107,484	4.57
1901	2,567,335	53,568,601	4.79
1902	1,959,466	31,200,890	6.28
1903	3,563,269	59,362,831	6.00
1904	2,800,466	57,492,522	4.87
1905	2,644,045	61,410,201	4.31
1906	3,846,501	55,698,595	6.91
1907	4,301,082	67,109,393	6.41
1908	3,646,250	64,665,014	5.64
1909	3,694,470	62,688,359	5.26
1910	3,296,318	65,712,761	5.02
1911	3,171,678	70,424,197	4.50

The following table shows the quantities of the different sizes of freshly mined coal and of washery coal shipped in 1910 and 1911:

Shipments, by sizes, from mines and washeries in 1910 and 1911, in long tons.

Size.	1910		1911	
	From mines.	From washeries.	From mines.	From washeries.
Lump and steamboat	722,767		530,999	
Broken	3,359,075		3,632,090	
Egg	7,947,100		8,464,265	
Stove	12,031,886	27	13,062,956	26
Chestnut	14,326,283	28,185	15,977,105	60,630
Pea	7,634,989	215,043	8,094,408	187,641
Buckwheat:				
No. 1	8,719,514	745,014	9,213,372	623,266
No. 2 and rice	4,891,994	1,259,684	5,096,850	1,142,284
No. 3 and barley	2,392,256	1,007,195	2,868,930	1,055,537
Screenings	390,579	41,170	311,544	102,294
Total	62,416,443	3,296,318	67,252,519	3,171,678

As shown in the preceding table, the stove and chestnut sizes are in the greatest demand and make up over 40 per cent of the total shipments. They are essentially domestic sizes, and the relatively large proportion they make of the shipments serves as an index to the conditions governing the anthracite trade. Egg coal finds its way principally to the furnaces of residences and pea coal is used in the same way to some extent, though it is also used for kitchen ranges and some of it goes with the buckwheat, etc., for use as steam coal. The small sizes come directly into competition with bituminous and sometimes are used mixed with bituminous coal for steam purposes, chiefly in hotels, apartment houses, and office buildings. If egg and chestnut are considered as domestic coals, the shipments of domestic sizes in 1911 aggregated 37,504,326 tons of the 67,252,519 tons of mine coal shipped during the year.

In the following table are presented statements showing the quantity and percentage of each size shipped from each county in 1910 and 1911:

Quantity and percentage of each size of anthracite shipped from each county in 1910 and 1911, in long tons.

1910.

County.	Lump and steamboat.		Broken.		Egg.		Stove.	
	Quantity.	Per cent.	Quantity.	Per cent.	Quantity.	Per cent.	Quantity.	Per cent.
Carbon	38,201	5.29	180,273	5.37	298,015	3.75	340,687	2.83
Columbia	16,599	2.30	24,328	.73	104,979	1.32	103,777	.86
Dauphin			27,463	.82	42,562	.54	95,362	.79
Lackawanna	41,106	5.69	538,418	16.03	1,846,128	23.23	3,548,387	29.49
Luzerne	221,338	30.62	1,520,253	45.26	3,410,093	42.91	4,671,497	38.83
Northumberland	50,904	7.04	160,580	4.79	495,863	6.24	987,841	8.21
Schuylkill	354,619	49.06	884,518	26.33	1,647,590	20.73	2,120,098	17.62
Sullivan			14,518	.41	50,209	.63	64,053	.53
Susquehanna			8,724	.26	51,661	.65	100,211	.84
Total	722,767	100.00	3,359,075	100.00	7,947,100	100.00	12,031,913	100.00

County.	Chestnut.		Pea.		Buckwheat No. 1.		Buckwheat No. 2 and rice.	
	Quantity.	Per cent.	Quantity.	Per cent.	Quantity.	Per cent.	Quantity.	Per cent.
Carbon	437,970	3.05	292,216	3.72	392,472	4.15	372,409	6.0
Columbia	182,442	1.27	91,305	1.16	122,362	1.29	75,355	1.2
Dauphin	99,661	.69	62,602	.80	143,702	1.52	121,564	1.9
Lackawanna	3,939,588	27.44	2,121,208	27.02	2,169,377	22.92	1,651,619	26.8
Luzerne	5,960,699	41.53	2,689,939	34.27	3,170,730	33.50	1,816,623	29.5
Northumberland	1,042,018	7.26	647,502	8.25	924,162	9.76	580,156	9.4
Schuylkill	2,457,086	17.12	1,804,709	22.99	2,456,691	25.96	1,524,569	24.7
Sullivan	100,077	.70	67,193	.86				
Susquehanna	134,927	.94	73,358	.93	85,032	.90	9,383	.1
Total	14,354,468	100.00	7,850,032	100.00	9,464,528	100.00	6,151,678	100.0

Quantity and percentage of each size of anthracite shipped from each county in 1910 and 1911, in long tons—Continued.

1910.

County.	Buckwheat No. 3 and barley.		Screenings.		Total.	
	Quantity.	Per cent.	Quantity.	Per cent.	Quantity.	Per cent.
Carbon	86,078	2.53			2,438,321	3.71
Columbia	7,223	.21			728,370	1.11
Dauphin	2,361	.07	7,671	1.78	602,948	.92
Lackawanna	1,518,030	44.66	17,066	3.95	17,390,927	26.46
Luzerne	1,314,123	38.66	111,066	25.73	24,886,361	37.87
Northumberland	71,437	2.10			4,960,463	7.55
Schuylkill	355,409	10.45	73,107	16.93	13,678,396	20.82
Sullivan			222,839	51,61	518,889	.79
Susquehanna	44,790	1.32			508,086	.77
Total	3,399,451	100.00	431,749	100.00	65,712,761	100.00

1911.

County.	Lump and steamboat.		Broken.		Egg.		Stove.	
	Quantity.	Per cent.	Quantity.	Per cent.	Quantity.	Per cent.	Quantity.	Per cent.
Carbon	20,158	3.80	173,761	4.78	283,119	3.34	368,218	2.82
Columbia	16,395	3.09	6,488	.18	105,783	1.25	141,185	1.08
Dauphin			24,562	.68	47,729	.56	108,862	.83
Lackawanna	21,266	4.00	569,848	15.69	2,132,722	25.20	3,700,818	28.33
Luzerne	189,113	35.61	1,684,729	46.38	3,636,823	42.97	5,260,157	40.27
Northumberland	18,962	3.57	199,949	5.51	496,441	5.86	1,054,065	8.07
Schuylkill	265,105	49.93	922,331	25.39	1,651,102	19.51	2,255,032	17.26
Sullivan			12,919	.36	54,907	.65	74,780	.57
Susquehanna			37,503	1.03	55,639	.66	99,865	.77
Total	530,999	100.00	3,632,090	100.00	8,464,265	100.00	13,062,982	100.00

County.	Chestnut.		Pea.		Buckwheat No. 1.		Buckwheat No. 2 and rice.	
	Quantity.	Per cent.	Quantity.	Per cent.	Quantity.	Per cent.	Quantity.	Per cent.
Carbon	549,793	3.43	338,719	4.09	372,147	3.78	278,778	4.47
Columbia	209,097	1.30	121,523	1.47	172,920	1.76	132,193	2.12
Dauphin	93,816	.59	55,040	.66	139,580	1.42	141,599	2.27
Lackawanna	4,345,345	27.10	2,225,293	26.87	2,371,171	24.10	1,799,528	28.84
Luzerne	6,618,953	41.27	2,772,594	33.48	3,117,826	31.70	1,688,735	27.07
Northumberland	1,208,915	7.54	687,719	8.30	1,025,962	10.43	641,347	10.28
Schuylkill	2,775,099	17.30	1,926,524	23.26	2,556,601	25.99	1,536,952	24.63
Sullivan	109,371	.68	75,195	.91				
Susquehanna	127,346	.79	79,442	.96	80,431	.82	20,002	.32
Total	16,037,735	100.00	8,282,049	100.00	9,836,638	100.00	6,239,134	100.00

County.	Buckwheat No. 3 and barley.		Screenings.		Total.	
	Quantity.	Per cent.	Quantity.	Per cent.	Quantity.	Per cent.
Carbon	126,828	3.23	1,154	0.28	2,512,675	3.57
Columbia	13,244	.34			918,828	1.30
Dauphin	38,913	.99	1,563	.38	651,664	.93
Lackawanna	1,729,354	44.07	15,914	3.84	18,911,259	26.85
Luzerne	1,331,623	33.93	93,005	22.47	26,393,558	37.48
Northumberland	128,101	3.26	5,902	1.43	5,467,363	7.76
Schuylkill	505,663	12.89	33,076	7.99	14,427,485	20.49
Sullivan			263,224	63.61	590,396	.84
Susquehanna	50,741	1.29			550,969	.78
Total	3,924,467	100.00	413,838	100.00	70,424,197	100.00

The following table gives the yearly shipments of anthracite, as reported by the Pennsylvania bureau of anthracite-coal statistics, from the earliest date to the close of 1911, divided according to the three trade regions. These shipments include only coal loaded on cars for line or tide points and do not include any coal sold locally or used at and about the mines nor the shipments from the Sullivan County mines.

Annual shipments from the Schuylkill, Lehigh, and Wyoming regions, 1820–1911, in long tons.

Year.	Schuylkill region.		Lehigh region.		Wyoming region.		Total.
	Quantity.	Percentage.	Quantity.	Percentage.	Quantity.	Percentage.	Quantity.
1820			365				365
1821			1,073				1,073
1822	1,480	39.79	2,240	60.21			3,720
1823	1,128	16.23	5,823	83.77			6,951
1824	1,567	14.10	9,541	85.90			11,108
1825	6,500	18.60	28,393	81.40			34,893
1826	16,767	34.90	31,280	65.10			48,047
1827	31,360	49.44	32,074	50.56			63,434
1828	47,284	61.00	30,232	39.00			77,516
1829	79,973	71 35	25,110	22.40	7,000	6.25	112,083
1830	89,984	51.50	41,750	23.90	43,000	24.60	174,734
1831	81,854	46.29	40,966	23.17	54,000	30.54	176,820
1832	209,271	57.61	70,000	19.27	84,000	23.12	363,271
1833	252,971	51.87	123,001	25.22	111,777	22.91	487,749
1834	226,692	60.19	106,244	28.21	43,700	11.60	376,636
1835	339,508	60.54	131,250	23.41	90,000	16.05	560,758
1836	432,045	63.16	148,211	21.66	103,861	15.18	684,117
1837	530,152	60.98	223,902	25.75	115,387	13.27	869,441
1838	446,875	60.49	213,615	28.92	78,207	10.59	738,697
1839	475,077	58.05	221,025	27.01	122,300	14.94	818,402
1840	490,596	56.75	225,313	26.07	148,470	17.18	864,379
1841	624,466	65.07	143,037	14.90	192,270	20.03	959,773
1842	583,273	52.62	272,540	24.59	252,599	22.79	1,108,412
1843	710,200	56.21	267,793	21.19	285,605	22.60	1,263,598
1844	887,937	54.45	377,002	23.12	365,911	22.43	1,630,850
1845	1,131,724	56.22	429,453	21.33	451,836	22.45	2,013,013
1846	1,308,500	55.82	517,116	22.07	518,389	22.11	2,344,005
1847	1,665,735	57.79	633,507	21.98	583,067	20.23	2,882,309
1848	1,733,721	56.12	670,321	21.70	685,196	22.18	3,089,238
1849	1,728,500	53.30	781,556	24.10	732,910	22.60	3,242,966
1850	1,840,620	54.80	690,456	20.56	827,823	24.64	3,358,899
1851	2,328,525	52.34	964,224	21.68	1,156,167	25.98	4,448,916
1852	2,636,835	52.81	1,072,136	21.47	1,284,500	25.72	4,993,471
1853	2,665,110	51.30	1,054,309	20.49	1,475,732	28.41	5,195,151
1854	3,191,670	53.14	1,207,186	20.13	1,603,478	26.73	6,002,334
1855	3,552,943	53.77	1,284,113	19.43	1,771,511	26.80	6,608,567
1856	3,603,029	52.91	1,351,970	19.52	1,972,581	28.47	6,927,580
1857	3,373,797	50.77	1,318,541	19.84	1,952,603	29.39	6,644,941
1858	3,273,245	47.86	1,380,030	20.18	2,186,094	31.96	6,839,369
1859	3,448,708	44.16	1,628,311	20.86	2,731,236	34.98	7,808,255
1860	3,749,632	44.04	1,821,674	21.40	2,941,817	34.56	8,513,123
1861	3,160,747	39.74	1,738,377	21.85	3,055,140	38.41	7,954,264
1862	3,372,583	42.86	1,351,054	17.17	3,145,770	39.97	7,869,407
1863	3,911,683	40.90	1,894,713	19.80	3,759,610	39.30	9,566,006
1864	4,161,970	40.89	2,054,669	20.19	3,960,836	38.92	10,177,475
1865	4,356,959	45.14	2,040,913	21.14	3,254,519	33.72	9,652,391
1866	5,787,902	45.56	2,179,364	17.15	4,736,616	37.29	12,703,882
1867	5,161,671	39.74	2,502,054	19.27	5,325,000	40.99	12,988,725
1868	5,330,737	38.52	2,502,582	18.13	5,968,146	43.25	13,801,465
1869	5,775,138	41.66	1,949,673	14.06	6,141,369	44.28	13,866,180
1870	4,968,157	30.70	3,239,374	20.02	7,974,660	49.28	16,182,191
1871	6,552,772	41.74	2,235,707	14.24	6,911,242	44.02	15,699,721
1872	6,694,890	34.03	3,873,339	19.70	9,101,549	46.27	19,669,778
1873	7,212,601	33.97	3,705,596	17.46	10,309,755	48.57	21,227,952
1874	6,866,877	34.09	3,773,836	18.73	9,504,408	47.18	20,145,121
1875	6,281,712	31.87	2,834,605	14.38	10,596,155	53.75	19,712,472

Annual shipments from the Schuylkill, Lehigh, and Wyoming regions, 1820–1911, in long tons—Continued.

Year.	Schuylkill region.		Lehigh region.		Wyoming region.		Total.
	Quantity.	Percentage.	Quantity.	Percentage.	Quantity.	Percentage.	Quantity.
1876	6,221,934	33.63	3,854,919	20.84	8,424,158	45.53	18,501,01
1877	8,195,042	39.35	4,332,760	20.80	8,300,377	39.85	20,828,179
1878	6,282,226	35.68	3,237,449	18.40	8,085,587	45.92	17,605,262
1879	8,960,829	34.28	4,595,567	17.58	12,586,293	48.14	26,142,689
1880	7,554,742	32.23	4,463,221	19.05	11,419,279	48.72	23,437,242
1881	9,253,958	32.46	5,294,676	18.58	13,951,383	48.96	28,500,017
1882	9,459,288	32.48	5,689,437	19.54	13,971,371	47.98	29,120,096
1883	10,074,726	31.69	6,113,809	19.23	15,604,492	49.08	31,793,027
1884	9,478,314	30.85	5,562,226	18.11	15,677,753	51.04	30,718,293
1885	9,488,426	30.01	5,898,634	18.65	16,236,470	51.34	31,623,530
1886	9,381,407	29.19	5,723,129	17.89	17,031,826	52.82	32,136,362
1887	10,609,028	30.63	4,347,061	12.55	19,684,929	56.82	34,641,018
1888	10,654,116	27.93	5,639,236	14.78	21,852,366	57.29	38,145,718
1889	10,486,185	29.28	6,294,073	17.57	19,036,835	53.15	35,817,093
1890	10,867,822	29.68	6,329,658	17.28	19,417,979	53.04	36,615,459
1891	12,741,258	31.50	6,381,838	15.78	21,325,240	52.72	40,448,336
1892	12,626,784	30.14	6,451,076	15.40	22,815,480	54.46	41,893,340
1893	12,357,444	28.68	6,892,352	15.99	23,839,741	55.33	43,089,537
1894	12,035,005	29.08	6,705,434	16.20	22,650,761	54.72	41,391,200
1895	14,269,932	30.68	7,298,124	15.69	24,943,421	56.63	46,511,477
1896	13,097,571	30.34	6,490,441	15.03	23,589,473	54.63	43,177,485
1897	12,181,061	29.26	6,249,540	15.00	23,207,263	55.74	41,637,864
1898	12,078,875	28.83	6,253,109	14.92	23,567,767	56.25	41,899,751
1899	14,199,009	29.79	6,887,909	14.45	26,578,286	55.76	47,665,204
1900	13,502,732	29.94	6,918,627	15.33	24,686,125	54.73	45,107,484
1901	16,019,591	29.92	7,211,974	13.45	30,337,036	56.63	53,568,601
1902	8,471,391	27.15	3,470,736	11.12	19,258,763	61.73	31,200,890
1903	16,474,790	27.75	7,164,783	12.07	35,723,258	60.18	59,362,831
1904	16,379,293	28.49	7,107,220	12.36	34,006,009	59.15	57,492,522
1905	17,703,099	28.83	7,849,205	12.78	35,857,897	58.39	61,410,201
1906	16,011,285	28.75	7,046,617	12.65	32,640,693	58.60	55,698,595
1907	20,141,288	30.01	8,320,653	12.41	38,638,452	57.58	67,109,393
1908	18,006,464	27.85	7,786,255	12.04	38,872,295	60.11	64,665,014
1909	16,864,147	27.21	7,532,271	12.16	37,573,467	60.63	61,969,885
1910	17,845,020	27.49	8,627,539	13.29	38,433,227	59.22	64,905,786
1911	19,375,369	27.70	9,775,018	13.97	40,803,912	58.33	69,954,299
Total	576,745,104	31.70	283,258,115	15.57	959,347,466	52.73	1,819,350,685

A tabular statement of the several sections of the anthracite fields is given in the following table:

Anthracite coal fields, by field, local district, and trade region.

Coal field or basin.	Local district.	Trade region.
Northern	Carbondale	Wyoming.
	Scranton	
	Pittston	
	Wilkes-Barre	
	Plymouth	
	Kingston	
Eastern middle	Green Mountain	Lehigh.
	Black Creek	
	Hazleton	
	Beaver Meadow	
	Panther Creek	
Southern	East Schuylkill	Schuylkill.
	Western Schuylkill	
	Lorberry	
	Lykens Valley	
Western middle	East Mahanoy	
	West Mahanoy	
	Shamokin	

The anthracite fields are reached by 11 so-called initial railroads, as follows:

- Philadelphia & Reading Railway.
- Lehigh Valley Railroad.
- Central Railroad of New Jersey.
- Delaware, Lackawanna & Western Railroad.
- Delaware & Hudson Co.'s Railroad.
- Pennsylvania Railroad.
- Erie Railroad.
- New York, Ontario & Western Railway.
- Delaware, Susquehanna & Schuylkill Railroad (part of Lehigh Valley system).
- New York, Susquehanna & Western Railroad (part of Erie system).
- Lehigh & New England Railroad (under construction).

PENNSYLVANIA BITUMINOUS COAL.

Total production in 1911, 144,754,163 short tons; spot value, $146,347,858.

The production of bituminous coal in Pennsylvania decreased from the maximum of 150,521,526 short tons in 1910 to 144,754,163 tons in 1911, the difference against 1911 being 5,767,363 tons, or 3.83 per cent. The value decreased from $153,029,510 to $146,347,858, a difference of $6,681,652, or 4.37 per cent. The decrease in production was almost entirely in that portion of the product used in the manufacture of coke, this alone showing a decrease of nearly 5,000,000 tons, or from 35,733,401 short tons in 1910 to 30,819,537 tons in 1911. All of the important coke-making counties except Westmoreland showed decreased production, and in Westmoreland County the quantity of coal used for coke making in 1911 was less than in 1910. Two counties in which largely decreased production was shown owed their lessened tonnage to an entirely different cause. These were Allegheny County, whose production fell off 971,541 short tons, and Washington County, whose output declined 1,294,905 tons. In both of these counties production in 1910 was stimulated by the shortage of coal caused by the strike in the Middle West, and their combined output increased over 6,400,000 tons. The smaller output in 1911 was due to the uninterrupted work in the States to the west. The decreases in these two counties in 1911 aggregated only a little more than one-third of the increase in 1910.

The largest decrease in 1911 was in Fayette County, which, with Westmoreland County, constitutes the famous Connellsville coking region, and which also, by itself, contains the entire lower Connellsville district, now the second coke-producing district in the United States. The decrease in Fayette County in 1911 was 4,294,165 short tons, of which 3,138,355 tons, or more than 73 per cent, was in the quantity of coal made into coke. Westmoreland County increased its production 1,216,791 short tons, but the quantity of coal used for coke making decreased 1,256,793 tons, indicating an increase in the consumption of Westmoreland County coal of about 2,450,000 tons for other purposes. One of the notable increases in production was that of Armstrong County, whose output in 1911 exceeded that of 1910 by 494,312 tons, or a little less than 15 per cent.

The average price per ton declined from $1.02 in 1910 to $1.01 in 1911, but the latter was 7 cents higher than the average for 1909, was the same as in 1908, and was higher than the general average in other recent years, except 1907. In fact, except as the depression in

e iron trade affected the coking branch of the industry, the bitu-
inous-coal trade in Pennsylvania in 1911 was well maintained and
dicates that general industrial conditions were satisfactory.

The number of men employed in the bituminous-coal mines of
ennsylvania in 1911 was 168,274, who worked an average of 233
ays, against 175,403 men for 238 days in 1910. The average pro-
uction per man in each year was practically the same, having been
58 tons in 1910 and 860 tons in 1911. The average daily production
er man in 1911 showed a slight increase over that of the preceding
ear, the figures being, respectively, 3.61 tons in 1910 and 3.69 tons
1911. All of these averages are above the mean average for the
ituminous coal-producing States, and there are only five States in
hich they are exceeded. The majority of the mines in the bitumi-
ous-coal region are worked 8 hours a day, there having been in 1911
42 mines, employing a total of 99,522 men, who worked 8 hours;
73 mines, employing 28,204 men, who worked 9 hours, and 214
ines, employing 37,661 men, who worked 10 hours.

The time lost by reason of strikes in the coal mines of Pennsyl-
ania in 1911 was negligible. The total number of men reported
lle from this cause was 5,601, or less than 4 per cent of the total
umber employed. The average time lost was 26 days, and the
otal time lost was less than 0.5 per cent of the time worked.

Although the total production of the State decreased nearly
,000,000 tons in 1911, compared with 1910, there was an increase of
30,882 short tons in the quantity of coal mined by machines, this
actor showing an increase from 68,501,041 short tons, or 45.51 per
ent of the total output in 1910, to 69,131,923 tons, or 47.76 per cent
f the total in 1911. Pennsylvania shows an enviable record in the
mall percentage of coal which is shot off the solid without having
een mined either by hand or machine. In 1911 the quantity of
oal reported as having been shot off the solid was 3,962,310 tons, or
ess than 3 per cent of the total. The quantity of coal reported as
ined by hand in 1911 was 49,527,801 short tons, or 34.2 per cent
f the total. There were 22,132,129 tons, or about 15 per cent of the
otal production, the methods employed in the mining of which were
ot reported. The total quantity of coal for which mining methods
ere reported was 122,622,034 tons, of which that mined by hand
as 40 per cent; that mined by machines was a little over 56 per
ent, and that shot off the solid was about 3.2 per cent. The machine-
ined production in 1911 (69,131,923 short tons) was won by the
se of 5,719 machines. In 1910 there were 5,505 machines in use,
nd in 1909, 5,616. The average production by each machine in 1911
as 12,088 tons. Of the 5,719 machines in use in 1911, 3,556 were
unchers, 1,874 were chain-breast, 82 long-wall, 188 short-wall, and
9 radialaxe or post punchers.

Very little of the bituminous coal produced in Pennsylvania is
ashed before being sold or used in the manufacture of coke. Less
han 1 per cent of the total product, or 1,346,982 short tons, was
ashed in 1911. That quantity yielded 1,226,326 tons of cleaned
oal and 120,656 tons of refuse.

According to reports to the United States Bureau of Mines, the
atal accidents in the bituminous-coal mines of Pennsylvania in 1911
otaled 529, a decrease from 601 in 1910. Of the 529 fatalities in
911, 496 were underground, 4 in shafts, and 29 on the surface.

Falls of roof and coal claimed 308 victims, mine-car and motor accidents 104, gas and dust explosions 31, powder explosions 2, and miscellaneous accidents 51. The death rate per thousand was 3.14 in 1911, against 3.07 in 1910, and the production to each life lost was 273,637 tons against 279,261 tons.

The statistics of production, by counties, with the distribution of the product for consumption in 1910 and 1911, are shown in the following table:

Bituminous-coal production of Pennsylvania in 1910 and 1911, by counties, in short tons.

1910.

County.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Made into coke.	Total quantity.	Total value.	Average price per ton.	Average number of days active.	Average number of employees.
Allegheny	17,788,864	745,430	299,566	1,476	18,835,336	$20,359,650	$1.08	228	23,877
Armstrong	3,062,669	136,712	105,534	....	3,304,915	3,111,518	.94	259	4,370
Beaver	183,253	42,299	2,674	....	228,226	279,483	1.22	283	388
Bedford	500,231	8,683	10,810	197,109	716,833	753,168	1.05	194	1,162
Blair	318,441	1,049	7,533	53,847	380,870	422,625	1.11	245	637
Butler	983,098	12,503	22,208	....	1,017,809	1,067,905	1.05	236	1,467
Cambria	14,481,395	427,320	325,876	1,394,870	16,629,461	17,566,903	1.06	240	23,501
Center	1,266,130	25,688	1,804	....	1,293,622	1,244,732	.96	235	1,829
Clarion	1,121,209	8,230	27,258	....	1,156,697	1,126,569	.97	226	1,713
Clearfield	7,641,725	244,972	204,301	372,912	8,463,910	8,048,056	.94	230	11,521
Clinton	299,578	9,353	2,042	....	310,973	378,898	1.22	239	396
Elk	1,109,056	28,683	23,254	41,330	1,202,323	1,186,650	.99	239	2,017
Fayette	7,479,414	309,082	553,859	22,754,878	31,097,233	31,210,480	1.00	265	24,707
Huntingdon	649,953	7,355	11,918	....	669,226	773,739	1.15	218	1,014
Indiana	8,414,684	45,831	199,935	293,916	8,954,366	8,277,938	.92	242	10,696
Jefferson	4,403,191	76,154	109,780	1,079,758	5,668,883	5,093,000	.90	236	6,391
Lawrence	81,282	5,243	8,577	....	95,102	115,276	1.21	214	459
Mercer	772,998	53,752	41,004	....	867,754	1,012,403	1.17	226	1,350
Somerset	8,499,755	78,891	198,738	60,298	8,837,682	9,191,483	1.04	263	9,836
Tioga	987,062	40,309	10,046	....	1,037,417	1,601,995	1.55	230	2,024
Washington	15,198,042	106,607	411,904	922,124	16,638,677	17,567,634	1.06	228	20,764
Westmoreland	13,263,703	449,844	617,694	8,554,163	22,885,404	22,389,051	.98	229	25,035
Other counties[a] and small mines	94,852	121,198	6,037	6,720	228,807	250,354	1.09	198	249
Total	108,600,585	2,985,188	3,202,352	35,733,401	150,521,526	153,029,510	1.02	238	175,403

1911.

Allegheny	17,011,945	535,160	313,677	3,013	17,863,795	$18,897,024	$1.06	223	22,504
Armstrong	3,544,645	128,236	125,635	711	3,799,227	3,625,900	.95	240	4,988
Beaver	137,400	63,446	2,710	....	203,556	246,515	1.21	265	357
Bedford	401,165	7,968	13,230	105,807	528,170	546,573	1.03	218	972
Blair	92,594	167,606	6,786	27,062	294,048	336,451	1.14	179	467
Butler	913,669	24,799	18,606	....	957,074	1,006,195	1.05	240	1,342
Cambria	14,348,596	959,172	367,299	1,253,561	16,928,628	17,499,255	1.03	238	21,900
Center	1,116,704	20,848	2,711	....	1,140,263	1,060,519	.93	223	1,712
Clarion	1,023,959	7,496	25,935	....	1,057,390	1,022,323	.97	233	1,816
Clearfield	7,074,270	231,132	211,847	335,177	7,852,426	7,464,258	.95	221	11,685
Clinton	305,833	7,577	1,233	....	314,643	388,703	1.24	202	387
Elk	1,097,515	64,952	20,978	40,411	1,223,856	1,183,395	.97	235	2,013
Fayette	6,423,155	259,869	503,521	19,616,523	26,803,068	26,886,299	1.00	245	22,456
Huntingdon	788,619	5,682	11,898	....	806,199	976,958	1.21	244	1,158
Indiana	8,186,918	48,843	205,585	339,637	8,780,983	8,303,008	.95	247	10,934
Jefferson	4,382,608	53,927	113,069	1,001,212	5,550,816	5,225,641	.94	245	5,397
Lawrence	75,937	3,935	10,279	....	90,151	109,698	1.22	227	166
Mercer	767,103	46,339	45,913	....	859,355	1,015,683	1.18	245	1,333
Somerset	8,847,001	123,603	206,015	802	9,177,421	9,376,554	1.02	248	9,573
Tioga	785,187	34,937	10,206	....	830,330	1,310,187	1.58	162	1,931
Washington	14,069,442	106,393	369,686	798,251	15,343,772	16,155,763	1.05	214	20,433
Westmoreland	15,601,722	528,190	674,913	7,297,370	24,102,195	23,437,522	.97	241	24,555
Other counties[b] and small mines	59,483	183,550	3,764	....	246,797	273,434	1.11	102	195
Total	107,055,470	3,613,660	3,265,496	30,819,537	144,754,163	146,347,858	1.01	233	168,274

[a] Bradford, Cameron, Greene, and Lycoming.

[b] Bradford, Cameron, Greene, Lycoming, and McKean.

The statistics of production, by counties, during the last five years, with increase and decrease in 1911 as compared with 1910, are shown in the following table:

Bituminous-coal production of Pennsylvania, 1907–1911, by counties, in short tons.

County.	1907	1908	1909	1910	1911	Increase (+) or decrease (—), 1911.
Allegheny	18,315,736	14,083,843	16,087,010	18,835,336	17,863,795	− 971,541
Armstrong	3,430,002	2,777,486	2,787,508	3,304,915	3,799,227	+ 494,312
Beaver	109,575	222,711	224,450	228,226	203,556	− 24,670
Bedford	967,313	511,014	435,129	716,833	528,170	− 188,663
Blair	493,219	315,167	410,161	380,870	294,048	− 86,822
Butler	902,729	802,462	828,043	1,017,809	957,074	− 60,735
Cambria	16,361,880	14,138,308	15,545,185	16,629,461	16,928,628	+ 299,167
Center	1,256,383	1,086,384	1,239,049	1,293,622	1,140,263	− 153,359
Clarion	1,078,367	972,785	941,059	1,156,697	1,057,390	− 99,307
Clearfield	8,034,711	6,247,534	7,573,322	8,463,910	7,852,426	− 611,484
Clinton	322,624	253,958	272,184	310,973	314,643	+ 3,670
Elk	1,427,841	1,147,209	1,150,675	1,202,323	1,223,856	+ 21,533
Fayette	29,260,622	19,474,417	28,866,229	31,097,233	26,803,068	− 4,294,165
Greene	158,187	145,644	137,448	77,321	31,743	− 45,578
Huntingdon	721,604	598,094	502,823	669,226	806,199	+ 136,973
Indiana	7,635,998	6,843,179	7,681,205	8,954,366	8,780,983	− 173,383
Jefferson	5,964,397	4,853,313	4,934,907	5,668,883	5,550,816	− 118,067
Lawrence	220,718	142,639	156,749	95,102	90,151	− 4,951
Lycoming	51,956	34,626	28,016	25,725	13,271	− 12,454
Mercer	955,290	724,158	893,880	867,754	859,355	− 8,399
Somerset	7,769,708	7,404,945	7,902,338	8,837,682	9,177,421	+ 339,739
Tioga	1,146,353	682,099	785,922	1,037,417	830,330	− 207,087
Washington	14,535,727	12,118,007	12,982,179	16,638,677	15,343,772	− 1,294,905
Westmoreland	28,916,721	21,499,292	25,432,320	22,885,404	24,102,195	+ 1,216,791
Small mines	[a] 105,516	[b] 100,253	[c] 169,000	[c] 125,761	[a] 201,783	+ 76,022
Total	150,143,177	117,179,527	137,966,791	150,521,526	144,754,163	− 5,767,363
Total value	$155,664,026	$118,816,303	$130,085,237	$153,029,510	$146,347,858	−$6,681,652

[a] Includes production of Bradford, Cameron, and McKean counties.
[b] Includes production of Bradford County.
[c] Includes production of Bradford and Cameron counties.

The statistics of the early production of bituminous coal in Pennsylvania, particularly as compared with the anthracite records, are sadly wanting. The United States Census of 1840 showed a production of bituminous coal in the State which amounted to 464,826 short tons. The census of 1860 showed a production of 2,690,786 short tons; that of 1870 showed a production of 7,798,518 short tons. The production for the intervening years, as shown in the table following, has been estimated from the best information obtainable. Since 1871 the records are official.

Production of bituminous coal in Pennsylvania from 1840 to 1911, in short tons.

Year.	Quantity.	Year.	Quantity.	Year.	Quantity.	Year.	Quantity.
1840	464.826	1859	2,400,000	1878	15,120,000	1897	54,417,974
1841	475,000	1860	2,690,786	1879	16,240,000	1898	65,165,133
1842	500,000	1861	3,200,000	1880	18,425,163	1899	74,150,175
1843	650,000	1862	4,000,000	1881	22,400,000	1900	79,842,326
1844	675,000	1863	5,000,000	1882	24,640,000	1901	82,305,946
1845	700,000	1864	5,839,000	1883	26,880,000	1902	98,574,367
1846	760,000	1865	6,350,000	1884	28,000,000	1903	103,117,178
1847	399,840	1866	6,800,000	1885	26,000,000	1904	97,938,287
1848	500,000	1867	7,300,000	1886	27,094,501	1905	118,413,637
1849	750,000	1868	7,500,000	1887	31,516,856	1906	129,293,206
1850	1,000,000	1869	6,750,000	1888	33,796,727	1907	150,143,177
1851	1,200,000	1870	7,798,518	1889	36,174,089	1908	117,179,527
1852	1,400,000	1871	9,040,565	1890	42,302,173	1909	137,966,791
1853	1,500,000	1872	11,695,040	1891	42,788,490	1910	150,521,526
1854	1,650,000	1873	13,098,829	1892	46,694,576	1911	144,754,163
1855	1,780,000	1874	12,320,000	1893	44,070,724		
1856	1,850,000	1875	11,760,000	1894	39,912,463	Total	2,396,491,260
1857	2,000.000	1876	12,880,000	1895	50,217,228		
1858	2,200,000	1877	14,000,000	1896	49,557,453		

TENNESSEE.

Total production in 1911, 6,433,156 short tons; spot value, $7,209,734.

The production of coal in Tennessee decreased from 7,121,380 short tons, valued at $7,925,350, in 1910 to 6,433,156 tons, valued at $7,209,734, in 1911. The decrease in quantity was 688,224 short tons, or 9.66 per cent, and the decrease in value was $715,616, or 9 per cent. Notwithstanding this rather notable decline, as compared with 1910, the output in 1911 was larger than that of 1909 and exceeded that of any preceding year except 1907. In a preliminary review of the coal trade of 1911 published in the closing week of that year the writer stated that the production of Tennessee, as of Alabama, was about 10 per cent less than in 1910. The reliability of the information on which these estimates were based is attested by the fact that complete returns show the decrease to have been 9.66 per cent. The decline in production in 1911 is not indicative of any "stress of weather" in the coal-mining industry of the State, for comparison with a series of preceding years shows that the tonnage was normal, and there was a small advance in the average price. Tennessee, with the other States of the Appalachian region, benefited by the long strike among the miners in the Mississippi Valley States, in the spring and summer of 1910, and production was unusually stimulated. The decreased tonnage in 1911 was simply a return to normal conditions.

The decreased production in 1911 was distributed generally throughout the State, there being but five counties—Hamilton, Overton, Fentress, Franklin, and Sequatchie—whose output increased. Scott County, which showed the largest increase in 1910, was the heaviest loser in 1911, one-third of the total decrease being in the output of that county. Another 30 per cent of the total decrease was in that of Claiborne County. Nearly 25 per cent of the entire decrease was in the quantity of coal made into coke, that factor showing a decline of 153,595 tons, from 615,558 tons in 1910 to 461,963 tons in 1911, and the quantity of coal made into coke represents considerably less than 10 per cent of the total output. The counties in which coke was made in 1911 were Grundy, Hamilton, Morgan, Rhea, and Roane. As the production in 1910 was stimulated by the idleness in the Mississippi Valley States, so from the same cause was the labor force augmented, and the average number of men employed increased to 11,930, from 10,031 in 1909. In 1911 with the resumption of mining in the other States, the number of men employed in the Tennessee mines fell off to 10,703. These, however, worked a larger average of days in 1911 than were made in 1910, the average number of days worked increasing from 225 in 1910 to 232 in 1911. The average production for each employee was 601 tons in 1911 against 597 tons in 1910; the average daily production per man was 2.59 tons in 1911 against 2.65 tons in 1910.

Tennessee's record with regard to the methods employed in the mining of coal is fair. From operators producing about 87 per cent of the total output in 1911, it appears that 40.5 per cent of the total production was mined by hand, 16.3 per cent was undercut by machines, and 43.2 per cent was shot from the solid. It may be inferred, therefore, that nearly 60 per cent of the coal produced was mined before being shot or wedged down. Exclusive of the machine-mined tonnage, 48 per cent of the output, for which the mining methods were reported, was hand mined and 52 per cent was shot from the solid.

According to reports to the United States Bureau of Mines, Tennessee and Alabama were the only States in which the fatal accidents from any other cause exceeded the number due to falls of roof and coal. In Tennessee 84 deaths out of a total of 115 and in Alabama 130 out of a total of 209 were due to mine explosions. Both had an extraordinarily high death rate, Alabama 9.2 per thousand and Tennessee 10.74. The quantity of coal produced in Tennessee for each life lost was 55,940 short tons. The fatalities in the Tennessee mines outside of those due to explosions were 31, of which 15 were due to falls and 6 to haulage-way accidents. Seven men were killed on the surface.

The statistics of production, by counties, in 1910 and 1911, with the distribution of the product for consumption, are shown in the following table:

Coal production of Tennessee in 1910 and 1911, by counties, in short tons.

1910.

County.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Made into coke.	Total quantity.	Total value.	Average price per ton.	Average number of days active.	Average number of employees.
Anderson	787,215	7,016	13,983		808,214	$848,611	$1.05	210	1,440
Campbell	1,651,770	27,381	26,386		1,705,537	2,016,029	1.18	207	3,230
Claiborne	1,473,487	7,462	14,865		1,495,814	1,527,018	1.02	246	1,706
Grundy	319,156	1,519	498	33,225	354,398	389,097	1.10	226	548
Hamilton	244,544	8,327	8,151	66,370	327,392	382,527	1.17	143	798
Marion	507,450	6,602	9,315	41,300	564,667	729,971	1.29	277	877
Morgan	362,439	9,324	9,857	100,693	482,313	472,866	.98	244	809
Overton	72,429	422	1,184		74,035	77,913	1.05	215	147
Scott	313,471	43,206	1,497	1,200	359,374	380,205	1.06	209	792
Other counties[a]	523,746	19,953	31,629	372,770	948,098	1,098,200	1.16	261	1,583
Small mines		1,538			1,538	2,913	1.90		
Total	6,255,707	132,750	117,365	615,558	7,121,380	7,925,350	1.11	225	11,930

1911.

County.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Made into coke.	Total quantity.	Total value.	Average price per ton.	Average number of days active.	Average number of employees.
Anderson	713,849	7,279	14,007		735,135	$793,788	$1.20	221	1,143
Campbell	1,638,806	29,563	35,297		1,703,666	1,991,780	1.17	235	2,918
Claiborne	1,262,137	9,620	15,951		1,287,708	1,277,248	.99	205	1,780
Grundy	242,983	1,175	170	19,712	264,040	287,203	1.09	175	458
Hamilton	289,253	6,543	8,251	61,084	365,131	435,795	1.19	220	637
Marion	504,568	4,315	8,233		517,116	668,136	1.29	262	889
Morgan	352,758	3,756	10,477	91,106	458,097	479,908	1.05	266	813
Overton	73,994	525	1,150		75,669	79,683	1.05	191	121
Scott	116,536	10,296	1,896		128,728	157,799	1.23	240	451
Other counties[b]	556,520	21,483	26,714	290,061	894,778	1,033,766	1.16	255	1,493
Small mines		3,088			3,088	4,628	1.50		
Total	5,751,404	97,643	122,146	461,963	6,433,156	7,209,734	1.12	232	10,703

[a] Bledsoe, Cumberland, Fentress, Rhea, Roane, Sequatchie, and White.
[b] Bledsoe. Cumberland, Fentress, Franklin, Rhea, Roane, Sequatchie, and White.

The statistics of production, by counties, during the last five years, with increase and decrease in 1911, as compared with 1910, are shown in the following table:

Coal production of Tennessee, 1907–1911, in short tons.

County.	1907	1908	1909	1910	1911	Increase (+) or decrease (−), 1911.
Anderson	851,943	854,197	822,803	808,214	735,135	− 73,079
Campbell	1,400,000	1,584,543	1,631,339	1,705,537	1,703,666	− 1,871
Claiborne	1,147,900	1,158,166	1,320,290	1,495,814	1,287,708	− 208,106
Cumberland	86,362	22,617	67,606	49,982	28,852	− 21,130
Grundy	564,591	572,101	422,898	354,398	264,040	− 90,358
Hamilton	382,044	58,743	217,080	327,392	365,131	+ 37,739
Marion	401,416	392,166	480,067	564,667	517,116	− 47,551
Morgan	639,207	585,134	469,537	482,313	458,097	− 24,216
Overton	74,734	46,078	50,864	74,035	75,669	+ 1,634
Rhea	242,421	173,719	104,128	156,296	147,599	− 8,697
Roane	170,748	162,669	188,016	193,918	180,293	− 13,625
Scott	197,165	128,437	127,376	359,374	128,728	− 230,646
White	425,328	326,729	316,510	346,206	324,339	− 21,867
Other counties and small mines	226,384	133,872	140,131	203,234	216,783	+ 13,549
Total	6,810,243	6,199,171	6,358,645	7,121,380	6,433,156	− 688,224
Total value	$8,490,334	$7,118,499	$6,920,564	$7,925,350	$7,209,734	−$715,616

The United States census of 1840 states that 558 short tons of coal were produced in Tennessee in that year. It is probable that very little was mined in the State prior to that date. By 1860 the production had increased to 165,300 tons, but after that date development was retarded by the Civil War. Since 1870 the production of Tennessee has increased rather regularly, but not so rapidly as that of Alabama. The annual production of the State since 1840 is shown in the following table:

Production of coal in Tennessee from 1840 to 1911, in short tons.

Year.	Quantity.	Year.	Quantity.	Year.	Quantity.	Year.	Quantity.
1840	558	1859	150,000	1878	375,000	1897	2,888,849
1841	600	1860	165,300	1879	450,000	1898	3,022,896
1842	1,000	1861	150,000	1880	495,131	1899	3,330,659
1843	4,500	1862	140,000	1881	840,000	1900	3,509,562
1844	10,000	1863	100,000	1882	850,000	1901	3,633,290
1845	18,000	1864	100,000	1883	1,000,000	1902	4,382,968
1846	25,000	1865	100,000	1884	1,200,000	1903	4,798,004
1847	30,000	1866	100,000	1885	1,440,957	1904	4,782,211
1848	40,000	1867	110,000	1886	1,714,290	1905	5,766,690
1849	52,000	1868	125,000	1887	1,900,000	1906	6,259,275
1850	60,000	1869	130,000	1888	1,967,297	1907	6,810,243
1851	70,000	1870	133,418	1889	1,925,689	1908	6,199,171
1852	75,000	1871	180,000	1890	2,169,585	1909	6,358,645
1853	85,000	1872	224,000	1891	2,413,678	1910	7,121,380
1854	90,000	1873	350,000	1892	2,092,064	1911	6,433,156
1855	100,000	1874	350,000	1893	1,902,258		
1856	115,000	1875	360,000	1894	2,180,879	Total	110,416,953
1857	125,000	1876	550,000	1895	2,535,644		
1858	135,000	1877	450,000	1896	2,663,106		

TEXAS.

Total production in 1911, 1,974,593 short tons; spot value, $3,273,288.

Texas was a notable exception in the matter of coal production in 1911 to the generally decreased output. Moreover, it was one of two States in which coal mining is an industry of considerable importance whose production in 1911 was the maximum. The output of anthracite in Pennsylvania was the largest in the history of that branch of the industry, but the decrease in the tonnage of bituminous production in that State more than offset the increased production of anthracite. Montana and North Dakota attained their maximum production in 1911, but the latter is relatively unimportant and the production is entirely lignite. The combined production of bituminous coal and lignite in Texas increased from 1,892,176 short tons, valued at $3,160,965 in 1910, to 1,974,593 short tons, valued at $3,273,288, in 1911, a gain of 82,417 short tons, or 4.36 per cent, in quantity and of $112,323, or 3.56 per cent, in value. The increase was almost entirely in the production of bituminous coal, which amounted to 1,083,952 short tons, valued at $2,491,361, in 1911, against 1,010,944 short tons, valued at $2,397,858, in 1910. The average price per ton declined from $2.37 to $2.30. The production of lignite increased from 881,232 short tons valued at $763,107 to 890,641 tons valued at $781,927. The average price of lignite advanced from 87 cents to 88 cents. Texas is the only State in which both bituminous coal and true lignite, or "brown coal," are produced in any material quantity, the black lignites or subbituminous coals of the Rocky Mountain States being distinctly different from true lignite, or brown coal.

Bituminous coal is produced in 7 counties of Texas, of which Palo Pinto County is the most important, with Erath second and Webb County third. Lignite production is distributed over 12 counties, of which Wood County, with an output of 264,520 short tons, in 1911, is the most important. Milam County, which at one time was the center of the lignite-producing industry, now ranks second in importance with a production in 1911 of 167,595 tons. The increased production of coal and lignite in 1911, as in 1910, may be attributed to the growing population and industrial development of the State, which consumes not only its own production but also considerable quantities brought in from Arkansas and Oklahoma on the north and Colorado and New Mexico on the northwest. It also produces and consumes large quantities of fuel oil. It is estimated by David T. Day, the United States Geological Survey's specialist in petroleum, that the consumption of fuel oil in Texas in 1911 was 6,500,000 barrels.

The number of men employed in the coal and lignite mines of Texas in 1911 was 5,353, who worked an average of 226 days, against 4,197 men and an average of 234 days in 1910. The bituminous mines employed 4,037 men for an average of 230 days, and the lignite mines employed 1,316 men for an average of 212 days. The average production per man was 268.5 tons for the year and 1.17 tons per day in the bituminous mines, and 676.8 tons for the year and 3.19 tons per day in the lignite mines. The general averages were 369 and 1.63 tons, respectively.

The quantity of coal mined by machines in Texas is relatively small, amounting in 1911 to 71,085 short tons, or 3.6 per cent of the total. Operators of mines in which machines are not used were for the most part unable to report for 1911 the percentage of their product mined by hand or shot off the solid. The tonnage for which the mining methods were reported represented 45.6 per cent of the total output, most of the reports stating that no account was kept or separation made of the coal shot from the solid or hand mined. Of the tonnage reported, however, 75 per cent was hand mined and 25 per cent was shot down without being mined. This record is highly favorable as compared with some of the other States in the Middle West. Some of the product from the Eagle Pass district has been materially improved in quality by washing. In 1911 there were 37,000 tons put through washeries, yielding 30,375 tons of cleaned coal and 6,625 tons of refuse. Coal mining in Texas in 1911 was practically free from labor troubles. As a usual thing the bituminous mines are worked 8 hours a day and the lignite mines 10 hours.

The fatal accidents in the coal and lignite mines of Texas in 1911 numbered 8, of which 5 were due to falls of roof and coal, 1 man was killed by mine cars, and 2 by explosions of powder.

The statistics of production, by counties, in 1910 and 1911, with the distribution of the product for consumption, are shown in the following table. Owing to the fact that there are only one or two mines in each county, the production of the bituminous-producing and of the lignite-producing counties, respectively, is combined.

Coal production of Texas in 1910 and 1911, in short tons.

1910.

County.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Total quantity.	Total value.	Average price per ton.	Average number of days active.	Average number of employees.
Bituminous:								
Erath	978,498	18,471	13,975	1,010,944	$2,397,858	$2.37	242	3,066
Maverick								
Palo Pinto								
Webb								
Wise								
Young								
Lignite:								
Bastrop	864,858	2,231	14,143	881,232	763,107	.87	210	1,131
Hopkins								
Houston								
Lee								
Leon								
Medina								
Milam								
Robertson								
Titus								
Van Zandt								
Wood								
Total	1,843,356	20,702	28,118	1,892,176	3,160,965	1.67	234	4,197

Coal production of Texas in 1910 and 1911, in short tons—Continued.

1911.

County.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Total quantity.	Total value.	Average price per ton.	Average number of days active.	Average number of employees.
Bituminous:								
Eastland	1,007,695	48,012	28,245	1,083,952	$2,491,361	$2.30	230	4,037
Erath								
Maverick								
Palo Pinto								
Webb								
Wise								
Young								
Lignite:								
Bastrop	870,206	8,900	11,535	890,641	781,927	.88	212	1,316
Hopkins								
Houston								
Lee								
Leon								
Medina								
Milam								
Rains								
Robertson								
Titus								
Van Zandt								
Wood								
Total	1,877,901	56,912	39,780	1,974,593	3,273,288	1.66	226	5,353

The first reported production of coal in Texas is contained in the volume of Mineral Resources of the United States for 1884. The production reported to the United States Geological Survey for that year was 125,000 tons. The growth of the industry from that date to the close of 1911 is shown in the following table:

Coal production of Texas from 1884 to 1911, in short tons.

Year.	Quantity.	Year.	Quantity.	Year.	Quantity.	Year.	Quantity.
1884	125,000	1892	245,690	1900	968,373	1908	1,895,377
1885	100,000	1893	302,206	1901	1,107,953	1909	1,824,440
1886	100,000	1894	420,848	1902	901,912	1910	1,892,176
1887	75,000	1895	484,959	1903	926,759	1911	1,974,593
1888	90,000	1896	544,015	1904	1,195,944		
1889	128,216	1897	639,341	1905	1,200,684	Total	22,031,534
1890	184,440	1898	686,734	1906	1,312,873		
1891	172,100	1899	883,832	1907	1,648,069		

UTAH.

Total production in 1911, 2,513,175 short tons; spot value, $4,248,666.

The coal production of Utah in 1911 was about the same as in 1910, the difference in totals exceeding two and a half million tons, being less than 5,000. The value increased $24,110, or a little more than 0.5 per cent. That the production did not show a larger decrease and that the value showed any increase at all was due to developments in Emery County, which trebled its production as compared with 1910, the output in 1911 being 120,000 tons as compared with 40,657 tons in 1910. The average price for the Emery County product advanced from $1.98 in 1910 to $2.09 in 1911. All of the other counties showed decreased production in 1911, and Carbon County, by far the most important producer, showed also a slight decline in price. Summit and Uinta counties had decreased tonnages but higher prices. In addition to being the most important coal-producing county, Carbon County is the only one in which coke is made. In 1911, 381,696 tons, an increase of 113,891 tons over 1910, were made into coke in Carbon County.

Returns from mining companies representing over 90 per cent of the total coal production of the State show that although less than 3 per cent of the output in 1911 was mined by machines, the practice of shooting from the solid has not obtained a strong foothold in Utah. Out of 2,256,979 short tons of which the methods of mining were reported, 1,993,574 short tons were undercut or sheared by hand and 70,653 tons were mined by machines. The quantity shot off the solid was 192,752 short tons, or about 7.7 per cent of the total output of the State. In spite of the small proportion of coal undercut by machines, the average tonnages won by the miners is considerably above the average bituminous production per man for the United States.

Labor troubles are not of frequent occurrence in the coal mines of Utah, and in this respect 1911 was consistent with the rule. Only one suspension of work because of dissatisfaction with conditions was reported. The miners affected were idle but 3 days. The mines are practically all worked 8 hours a day.

The men employed in the coal mines of Utah in 1911 numbered 3,060 who worked an average of 236 days, against 3,053 men for 260 days in 1910. The average production for each man employed was about the same in both years, being 824.7 in 1910 and 821.3 in 1911. The daily efficiency in 1911 was better than in 1910, the average daily tonnages per man in the two years being, respectively, 3.5 and 3.17.

The United States Bureau of Mines reports 14 fatal accidents in the coal mines of Utah in 1911, 12 underground and 2 on the surface. Of the 12 accidents underground, 10 were due to falls of roof or coal. The death rate per thousand employees was 4.58, and there were 179,513 tons mined for each life lost.

The statistics of production, by counties, in 1910 and 1911, with the distribution of the product for consumption, are shown in the following table:

Coal production of Utah in 1910 and 1911, by counties, in short tons.

County.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Made into coke.	Total quantity.	Total value.	Average price per ton.	Average number of days active.	Average number of employees.
1910.									
Carbon	1,954,389	8,692	80,863	267,805	2,311,749	$3,882,205	$1.68	274	2,549
Emery	34,043	3,414	3,200		40,657	80,566	1.98	149	229
Summit	141,020	3,301	10,282		154,603	235,881	1.53	222	260
Uinta		8,590			8,590	21,675	2.52	226	15
Small mines		2,210			2,210	4,229	1.92		
Total	2,129,452	26,207	94,345	267,805	2,517,809	4,224,556	1.68	260	3,053
1911.									
Carbon	1,788,791	10,409	83,142	381,696	2,264,038	$3,780,638	$1.67	241	2,566
Emery and Sanpete	109,102	8,274	2,880		120,256	250,741	2.09	186	255
Summit	106,999	2,372	12,768		122,139	200,740	1.64	232	222
Uinta		4,089			4,089	11,263	2.75	205	17
Small mines		2,653			2,653	5,284	1.99		
Total	2,004,892	27,797	98,790	381,696	2,513,175	4,248,666	1.69	236	3,060

The production by counties during the last five years, with increase and decrease in 1911 as compared with 1910, has been as follows:

Coal production of Utah, 1907–1911, by counties, in short tons.

County.	1907	1908	1909	1910	1911	Increase (+) or decrease (−) 1911.
Carbon	1,836,439	1,719,835	2,125,789	2,311,749	2,264,038	− 47,711
Emery	5,052	3,725	1,690	40,657	a 120,256	+ 79,599
Morgan	3,736	4,500	2,000			
Sanpete						
Summit	102,025	116,534	134,838	163,193	126,228	− 36,965
Uinta						
Small mines	355	2,198	2,582	2,210	2,653	+ 443
Total	1,947,607	1,846,792	2,266,899	2,517,809	2,513,175	− 4,634
Total value	$2,959,769	$3,119,338	$3,751,810	$4,224,556	$4,248,666	+$24,110

a Includes Sanpete County.

The Ninth United States Census recorded the first production of coal in Utah with an output of 5,800 tons. Ten years later the production amounted to less than 15,000 tons. It assumed some importance in 1882 when the production amounted to 100,000, and reached the million-ton mark in 1900. In 1909 it exceeded 2,000,000 tons. The annual production since 1870 has been as follows:

Annual production of coal in Utah, 1870–1911, in short tons.

Year.	Quantity.	Year.	Quantity.	Year.	Quantity.	Year.	Quantity.
1870	5,800	1881	52,000	1892	361,013	1903	1,681,409
1871		1882	100,000	1893	413,205	1904	1,493,027
1872		1883	200,000	1894	413,550	1905	1,332,372
1873		1884	200,000	1895	471,836	1906	1,772,551
1874		1885	213,120	1896	418,627	1907	1,947,607
1875		1886	200,000	1897	521,560	1908	1,846,792
1876	50,400	1887	180,021	1898	593,709	1909	2,266,899
1877	50,400	1888	258,961	1899	786,049	1910	2,517,809
1878	67,200	1889	236,651	1900	1,147,027	1911	2,513,175
1879	50,000	1890	318,159	1901	1,322,614		
1880	14,748	1891	371,045	1902	1,574,521	Total.	27,981,857

VIRGINIA.

Total production in 1911, 6,864,667 short tons; spot value, $6,254,804.

Virginia is the only State of the Appalachian region whose production of coal in 1911 exceeded that of 1910. In Kentucky the production of the eastern counties, which are included in the Appalachian coal field, was larger in 1911 than in 1910, but the total production of the State decreased. Virginia's production increased from 6,507,997 short tons valued at $5,877,486, in 1910 to 6,864,667 tons, valued at $6,254,804, in 1911, the gain being 356,670 short tons, or 5.48 per cent, in quantity and $377,318, or 6.42 per cent, in value. All of the important producing counties, except Lee County, showed increases, the principal gain being due to the developments in Russell County by the Clinchfield Coal Corporation, following the completion in 1910 of the Carolina, Clinchfield & Ohio Railway from Dante and Hurricane, where the mines are opened, to Spartanburg, S. C., where connections are made with other lines giving outlet to the seaboard of the South

Atlantic States. Connections for western trade are made with the Louisville & Nashville Railroad at St. Paul, a few miles from the mines. Russell County in 1909 produced about 440,000 tons; in 1910 the production was a little less than 750,000 tons, and in 1911 it exceeded 1,050,000 tons, or nearly 50 per cent more than Lee County. The decreased production in Lee County in 1911 was due to the depression in the iron trade and the slack demand for coke, the quantity of coal used in coke making showing a loss from 140,575 tons in 1910 to 25,598 tons in 1911. Coke making also showed notable declines in Tazewell and Wise counties, the quantity of coal made into coke in the former decreasing from 262,668 tons in 1910 to 189,367 tons in 1911, while in the latter it decreased from 1,805,467 tons to 1,154,799 tons, but in these two counties the losses in coke making were more than counterbalanced by gains in shipments. The total decrease in the quantity of coal used for coke making in Virginia was from 2,208,710 tons to 1,369,764 tons, a loss of 838,946 tons, or 38 per cent.

Other new development, or, in this case redevelopment, work in Virginia was that on the old Gayton properties in the Richmond Basin. This, as mentioned in the report for 1910, had resulted in putting the mines in operation in that year. A considerable tonnage was reported for 1911. The new equipment at the Gayton mines includes a washing plant, and all of the coal produced in 1911 was washed.

Virginia stands well up among the States in the quantity of coal produced by each man employed, but suffers somewhat by comparison with some other Appalachian States, particularly with West Virginia, in the percentage of coal shot off the solid. In 1911 there were 7,392 men employed in the coal mines of Virginia. The average number of days worked was 261. In 1910, 7,264 men were employed for an average of 241 days. The average production per man in 1911 was 929 tons for the year and 3.56 tons per day, against 896 tons and 3.72 tons, respectively, in 1910. The lower daily record for 1911 was due, in part at least, to the number of men employed during the year in the redevelopment of the old Gayton mines in the Richmond Basin. The averages for Virginia, both in 1910 and 1911, are considerably above those made in most of the coal-producing States. Most of the mines are worked 10 hours a day. No labor troubles of any character were reported in 1911.

In 1911, out of a total of 6,864,667 short tons, 2,442,562 tons, or 35.6 per cent, were shot off the solid; 1,865,320 tons, or 27.2 per cent, were undercut by hand, and 2,551,627 tons, or 37 1 per cent, were machine-mined In the number of mining machines and in the quantity and percentage of coal mined by machines, Virginia took a forward step in 1911. The number of machines reported in use in 1910 was 142, and the quantity of coal mined by them was 2,290,435 short tons In 1911 there were 156 machines reported and the machine-mined coal amounted to 2,551,627 tons. The percentages of machine-mined coal to the total production were 35 2 in 1910 and 37 1 in 1911. Of the 156 machines in use in 1911 not one was of the percussion type represented by the pick, radialaxe, or post-puncher machines The chain-breast and short-wall machines hold the field, there being 121 of the former and 35 of the latter in 1911. The average production for each machine in use was 16,357 tons

There were three coal-washing plants in operation during 1911, the one at Gayton, already mentioned, that at the Parrott mine in Pulaski County, and the one at Darby, in Lee County. The quantity of coal washed in 1911 was 50,297 short tons, which yielded 42,417 tons of cleaned coal and 7,880 tons of refuse

As the percentage of coal shot off the solid in Virginia is high, so is the accidental death rate. The United States Bureau of Mines reports a total of 68 deaths in the coal mines of Virginia in 1911. The death rate per thousand was 9.2, exceeded by only one State, Tennessee, and equaled by one other, Alabama The quantity of coal mined for each life lost was 100,951 tons Thirty-five, or more than half the deaths, were due to falls of roof and coal, 18 were caused by mine cars and motors, and 5 were due to explosions of gas or dust. Eight men were killed on the surface.

The statistics of production, by counties, in 1910 and 1911, with the distribution of the product for consumption, are shown in the following table:

Coal production of Virginia in 1910 and 1911, in short tons.

1910.

County.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Made into coke.	Total quantity.	Total value.	Average price per ton.	Average number of days active.	Average number of employees.
Lee	643,871	4,448	8,202	140,575	797,096	$768,990	$0.90	254	946
Tazewell	847,578	30,588	46,312	262,668	1,187,146	1,169,981	.99	196	1,191
Wise	1,815,392	40,116	70,017	1,805,467	3,730,992	3,274,809	.88	259	4,449
Other counties [a] and small mines	756,541	13,132	23,090	....	792,763	663,706	.84	180	678
Total	4,063,382	88,284	147,621	2,208,710	6,507,997	5,877,486	.90	241	7,264

1911.

County.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Made into coke.	Total quantity.	Total value.	Average price per ton.	Average number of days active.	Average number of employees.
Lee	667,611	5,656	21,830	25,598	720,695	$724,498	$1.01	250	776
Tazewell	1,027,786	25,682	38,389	189,367	1,281,224	1,209,138	.94	210	1,352
Wise	2,470,449	39,769	89,343	1,154,799	3,754,360	3,301,984	.88	274	3,582
Other counties [a] and small mines	1,065,048	11,242	32,098	....	1,108,388	1,019,184	.92	279	1,682
Total	5,230,894	82,349	181,660	1,369,764	6,864,667	6,254,804	.91	261	7,392

[a] Henrico, Montgomery, Pulaski, and Russell.

The statistics of production, by counties, for the last five years, with increase and decrease in 1911 as compared with 1910, are shown in the following table:

Coal production of Virginia, 1907–1911, by counties, in short tons.

County.	1907	1908	1909	1910	1911	Increase (+) or decrease (−) 1911.
Tazewell	1,116,534	980,014	975,665	1,187,146	1,281,224	+ 94,078
Wise	3,145,846	2,558,874	2,841,448	3,730,992	3,754,360	+ 23,368
Pulaski	[a] 448,515	[a] 719,954	[a] 931,276	[b] 1,587,162	[b] 1,827,751	+ 240,589
Small mines	....	200	3,828	2,697	1,332	− 1,365
Total	4,710,895	4,259,042	4,752,217	6,507,997	6,864,667	+ 356,670
Total value	$4,807,533	$3,868,524	$4,251,056	$5,877,486	$6,254,804	+$377,318

[a] Includes Lee, Montgomery, and Russell counties.
[b] Includes Henrico, Lee, Montgomery, and Russell counties.

To Virginia belongs the distinction of having produced the first bituminous coal mined in the United States. This initial output, however, was not from that portion of the State which now gives Virginia some prominence as a producer of coal, but was obtained from what is generally known as the Richmond Basin, a small area of Triassic age in the southeastern part of the State, near the city of Richmond. The basin is on the eastern margin of the Piedmont Plateau, 13 miles above tide on the James River, and is included within the counties of Goochland, Henrico, Powhatan, and Chesterfield.

The occurrence of coal in this locality was known as early as 1700, though mining did not begin until the latter part of the century. In 1789 shipments were made to some of the Northern States. In 1822, according to Mr. R. C. Taylor, in his "Statistics of Coal," the production amounted to 54,000 short tons. For nearly a century the Richmond Basin maintained some prominence as a coal producer, but when, in 1882, the Pocahontas district was opened up, followed shortly afterwards by the development of the New River field in West Virginia, the mines in the Richmond Basin were put at a disadvantage and operations were practically suspended. During the last two years, through the efforts of the Old Dominion Development Co., the old mines at Gayton, in Henrico County, have been reopened with modern mechanical equipment, including a coal washery, and mining operations were resumed in 1910.

The mining of coal in southwestern Virginia, whence the present production chiefly comes, began with the completion of the New River division of the Norfolk & Western Railway in 1883, in which year the first carload of Pocahontas coal was shipped to Norfolk and distributed among the poor. During the next 10 years nearly the entire production of the State was obtained from this locality in Tazewell County, which forms a part of the famous Pocahontas-Flat Top coal field. Ten years from the opening of this district, or in 1892, the extension of the Clinch Valley branch of the Norfolk & Western Railway made accessible rich coal fields in Wise County, the first production in that county having been reported in 1893, when it amounted to 126,216 tons, while that of Tazewell County was 653,374 tons. In 1897 the Wise County production exceeded that of Tazewell County, and since that date Wise County has rapidly become the principal coal-producing county of the State, having in 1911 had nearly three times the output of Tazewell County. The year 1907, practically 15 years from the opening of the Wise County field, and 25 years from the development of the Pocahontas district, marked the beginning of coal mining in another county of Virginia which promises to show a development rivaling the rapid growth of Wise County. The development of the coal resources of Lee County was begun in 1905 in the area known as the "Pocket" district, a short description of which was given in a previous report.[1] The mines at Dante, in Russell County, were opened in 1904 and have been described by R. W. Stone in United States Geological Survey Bulletin 316. In 1911 that district produced over 1,000,000 tons of coal.

The annual production of Virginia from 1822 to the close of 1911 is shown in the following table:

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[1] Bull. U. S. Geol. Survey No. 341, 1909, pp. 411–418.

Production of coal in Virginia from 1822 to 1911, in short tons.

Year.	Quantity.	Year.	Quantity.	Year.	Quantity.	Year.	Quantity.
1822	54,000	1845	350,000	1868	59,051	1891	736,399
1823	60,000	1846	340,000	1869	65,000	1892	675,205
1824	67,040	1847	325,000	1870	61,803	1893	820,339
1825	75,000	1848	318,000	1871	70,000	1894	1,229,083
1826	88,720	1849	315,000	1872	69,440	1895	1,368,324
1827	94,000	1850	310,000	1873	67,200	1896	1,254,723
1828	100,080	1851	310,000	1874	70,000	1897	1,528,302
1829	100,000	1852	325,000	1875	60,000	1898	1,815,274
1830	102,800	1853	350,000	1876	55,000	1899	2,105,791
1831	118,000	1854	370,000	1877	50,000	1900	2,393,754
1832	132,000	1855	380,782	1878	50,000	1901	2,725,873
1833	125,000	1856	352,687	1879	45,000	1902	3,182,993
1834	124,000	1857	363,605	1880	43,079	1903	3,451,307
1835	120,000	1858	377,690	1881	50,000	1904	3,410,914
1836	124,000	1859	359,055	1882	112,000	1905	4,275,271
1837	160,000	1860	473,360	1883	252,000	1906	4,254,879
1838	300,000	1861	445,165	1884	336,000	1907	4,710,895
1839	396,000	1862	445,124	1885	567,000	1908	4,259,042
1840	424,894	1863	[a] 40,000	1886	684,951	1909	4,752,217
1841	379,600	1864	40,000	1887	825,263	1910	6,507,997
1842	373,640	1865	40,000	1888	1,073,000	1911	6,864,667
1843	370,000	1866	40,000	1889	865,786		
1844	365,000	1867	50,000	1890	784,011	Total	79,613,075

[a] West Virginia separated from Virginia.

WASHINGTON.

Total production in 1911, 3,572,815 short tons; spot value, $8,174,170.

Washington is the only one of the Pacific coast States in which coal mining is an industry of any importance. But Washington, although more remote, is like Oregon in that it is now feeling the influence of the competition of California fuel oil. Even the railroads having their own coal mines are using fuel oil in their locomotives on the mountain divisions where a sparkless fuel gives protection against forest fires. Some of the Washington coal mines are within less than 50 miles of Puget Sound, yet most of the steamers plying in those waters are using oil for fuel, the saving in labor and the cleanliness of the liquid fuel giving it a decided advantage over coal even when the latter may be cheaper at first cost. The decreased production of coal in Washington seems to be assignable to no other cause than the substitution of oil for coal, as trade conditions generally in 1911 were satisfactory. The production of coal in Washington decreased from 3,911,899 short tons in 1910 to 3,572,815 tons in 1911, a loss of 339,084 tons, or 8.67 per cent. The value decreased from $9,764,465 to $8,174,170, a loss of $1,590,295, or 16.29 per cent. The principal decrease in production was in Kittitas County, in which the larger part of the tonnage is from mines controlled by the Northern Pacific Railway. In fact, the decrease in Kittitas County was more than that of the State as a whole, and bears witness to the influence of the use of oil in railroad locomotives.

The number of men employed in the coal mines of Washington in 1911 was 6,498, who worked an average of 225 days, against 6,314 men and 256 days in 1910. The average production by each man employed was 550 tons for the year and 2.44 tons for each working day in 1911, against 620 tons and 2.42 tons, respectively, in 1910.

In 1910 only one company in Washington reported the use of mining machines. In 1911 three companies reported machines in connection with their coal-mining operations, and on account of the steep inclination of most of the coal beds of Washington, the radialaxe or post-puncher type of machine is the only one employed. Of that type there were 23 in use in 1911, an increase of 5 over 1910. The quantity of coal mined by the use of machines in 1911 was 188,707 tons, an increase from 56,000 tons in 1910, a gain of 132,707 tons, or 237 per cent, and was equal to 5 per cent of the total production of coal in the State. Most of the coal produced in Washington is mined by hand, there being 2,247,074 tons, or 63 per cent, which were undercut or otherwise mined by hand, and 987,196 tons, or 28 per cent of the total, shot off the solid, in 1911, while the mining methods were not reported in connection with 149,838 tons, or 4 per cent of the total.

Six of the mines of the Northwestern Improvement Co. were idle nearly two weeks because of labor troubles, and at one other mine in the State a strike of seven days occurred. The average time lost was 10 days, and the number of men idle was 2,099. At eight of the mines in the State washing plants have been installed, and 392,503 short tons of coal were washed in 1911, some of the washed coal being used in the manufacture of coke. The cleaned coal amounted to 338,708 short tons, and the refuse to 53,795 tons.

The returns to the United States Bureau of Mines show that 27 men were killed in 1911 in the coal mines of Washington, the death rate per thousand employees was 4.16, and the number of tons mined for each life lost was 132,326.

The statistics of production, by counties, in 1910 and 1911, with the distribution of the product for consumption, are shown in the following table:

Coal production of Washington in 1910 and 1911, by counties, in short tons.

1910.

County.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Made into coke.	Total quantity.	Total value.	Average price per ton.	Average number of days active.	Average number of employees.
King	1,070,948	107,404	63,988	....	1,242,340	$2,828,123	$2.28	258	2,01
Kittitas	1,602,766	16,112	42,772	....	1,661,650	4,693,297	2.82	244	2,44
Lewis	160,743	11,745	6,996	....	179,484	377,530	2.10	230	25
Pierce	646,465	5,474	40,115	94,042	786,096	1,788,110	2.27	276	1,53
Other counties [a]	41,425	196	708	....	42,329	77,405	1.83	251	7
Total	3,522,347	140,931	154,579	94,042	3,911,899	9,764,465	2.50	256	6,31
1911.									
King	1,074,780	120,981	63,760	....	1,259,521	$2,745,507	$2.18	246	1,87
Kittitas	1,200,476	14,943	41,326	....	1,256,745	3,361,271	2.67	188	1,93
Lewis	148,722	14,949	9,063	....	172,734	325,799	1.89	183	1,03
Pierce	709,125	4,044	22,275	47,752	783,196	1,550,049	1.98	275	1,51
Other counties [a]	97,888	1,015	1,716	....	100,619	191,544	1.90	229	13
Total	3,230,991	155,932	138,140	47,752	3,572,815	8,174,170	2.29	225	6,49

[a] Thurston and Whatcom.

The statistics of production, by counties, during the last five years, with increase and decrease in 1911 as compared with 1910, are shown in the following table:

Production of coal in Washington, 1907–1911, in short tons.

County.	1907	1908	1909	1910	1911	Increase (+) or decrease (−), 1911.
Cowlitz	[a] 7,424					
King	1,445,633	931,643	1,216,012	1,242,340	1,259,521	+ 17,181
Kittitas	1,524,887	1,414,621	1,550,539	1,661,650	1,256,745	− 404,905
Lewis	103.539	73,675	121,573	179,484	172,734	− 6,750
Pierce	572,169	551,678	609,467	786,096	783,196	− 2,900
Other counties	26,880	53.326	[b] 104,672	42,329	100,619	+ 58,290
Total	3,680,532	3,024,943	3,602,263	3,911,899	3,572,815	− 339,084
Total value	$7,679,801	$6,690,412	$9,158,999	$9,764,465	$8,174,170	−$1,590,295

[a] Includes Whatcom County.

[b] Includes small mines.

The United States Census report for 1860 contains the first record of coal production in Washington. This production was entirely from the Bellingham Bay properties, in Whatcom County, and amounted to 5,374 tons. The State did not assume much importance as a coal producer, however, until the opening of the Green River field, in King County, between 1880 and 1885, and of the Roslyn mines, in Kittitas County, which began producing about the same time. The growth of the industry since 1860, when production in Washington began, is shown in the following table:

Production of coal in Washington, 1860–1911, in short tons.

Year.	Quantity.	Year.	Quantity.	Year.	Quantity.	Year.	Quantity.
1860	5,374	1874	30,352	1888	1,215,750	1902	2,681,214
1861	6,000	1875	99,568	1889	1,030,578	1903	3,193,273
1862	7,000	1876	110,342	1890	1,263,689	1904	3,137,681
1863	8,000	1877	120,896	1891	1,056,249	1905	2,864,926
1864	10,000	1878	131,660	1892	1,213,427	1906	3,276,184
1865	12,000	1879	142,666	1893	1,264,877	1907	3,680,532
1866	13,000	1880	145,015	1894	1,106,470	1908	3,024,943
1867	14,500	1881	196,000	1895	1,191,410	1909	3,602,263
1868	15,000	1882	177,340	1896	1,195,504	1910	3,911,899
1869	16,200	1883	244,990	1897	1,434,112	1911	3,572,815
1870	17,844	1884	166,936	1898	1,884,571		
1871	20,000	1885	380,250	1899	2,029,881	Total.	57,220,617
1872	23,000	1886	423,525	1900	2,474,093		
1873	26,000	1887	772,601	1901	2,578,217		

WEST VIRGINIA.

Total production in 1911, 59,831,580 short tons; spot value, $53,670,515.

West Virginia, for the last three years the second in rank among the coal-producing States, stands almost alone in one particular, the low average price which its coal, some of it the highest grade bituminous coal produced in the United States, brings to the producer. The only State that rivals West Virginia in this particular is Virginia, whose areas in the southwestern part of the State are contiguous to those of southern West Virginia, and the conditions affecting the production and marketing of the product of both Commonwealths are similar. Neither has any well-developed local markets, and at least 80 per cent of the output is shipped to distant points for consumption. The highest average price for West Virginia coal recorded in the last eight years was in the boom year, 1907, when it reached 99 cents per short ton. In the same year the average price obtained for Virginia coal was $1.02. In 1911 the average price for West Virginia coal was 90 cents. A comparision of these prices with those of some of the important coal-producing States places West Virginia in an unfavorable light. Illinois, which until displaced by West Virginia in 1909 was second in rank of output, supplies fuel to important manufacturing communities within its borders or in immediately adjacent territory, and the grade of its product is considerably below that of West Virginia. The average price for Illinois coal has ranged from $1.05 to $1.14 per short ton, about 20 per cent higher than that obtained for West Virginia coal. Comparisons with Alabama are still more striking. Alabama in its important iron industry has a local outlet for the most of its coal. During the last eight years the average price has ranged from $1.19 in 1909 to $1.34 in 1906, more than 30 per cent better than West Virginia prices. In its high-grade, cheaply mined, low-priced fuel West Virginia offers advantages to the development of manufactures that should place it among the leading manufacturing States. It stands twenty-ninth. In supplying its fuel to other communities West Virginia may be playing the rôle of benefactor, but in the long run it is anticonservational and bad economy for the State.

West Virginia was no exception to the coal-producing States outside of the Mississippi Valley region that profited by the strike in that region in 1910. Its production gained nearly 10,000,000 tons over that of 1909, with an increase in value of more than $12,000,000. With uninterrupted work in the other States in 1911 a decrease in the production of West Virginia was to be expected, and did occur. The decrease was relatively small, however, and the production when compared with the years preceding 1910 shows a substantial increase. In the 49 years since West Virginia became a separate State there have been only six years in which comparison with the preceding year was indicated by the minus sign. They were 1869, 1876, 1881, 1895, 1908, and 1911—only three in the last 30 years.

The production in 1910 was 61,671,019 short tons, compared with which the output in 1911 (59,831,580 short tons) shows a decrease of 1,839,439 tons, or 2.98 per cent. The value declined from $56,665,061 to $53,670,515, a loss of $2,994,546, or 5.3 per cent. The average price per ton dropped from 92 cents to 90 cents. There were 17 counties, the production of which can be given separately, in which decreases were shown and 13 in which production showed a gain. Raleigh County, which has been the scene of active development in the last few years, carried off the honors of increased production with a gain of 1,062,301 short tons, or 30 per cent. Kanawha suffered the principal decrease, with a loss of 1,297,828 tons, or 18 per cent. In 1910 Kanawha County's production was increased nearly 1,500,000 tons by the shortage of coal in the States to the west the Kanawha district being one of the nearest to the strike-affected region. The decrease in 1911 was therefore merely a return to norma conditions.

It is further to be noted that the depression in the iron trade and slack demand for coke were the chief factors in the decrease of West Virginia's production, the decrease in the quantity of coal made into coke (2,583,242 short tons, or more than 40 per cent) being more than the total decrease in the State.

The number of men employed in the coal mines of West Virginia in 1911 was 66,730, who worked an average of 221 days. The average production per man was 896 short tons for the year, and 4.05 tons for each working day. In 1910 68,663 men worked an average of 228 days and produced an average of 898 tons for the year and 3.94 tons per day.

In one respect the record of West Virginia's coal production in 1911 stands out as a shining light—that is, in the exceptionally low percentage of coal shot off the solid. The returns to the Survey show that out of a total output of 59,831,580 tons in 1911, 57,175,485 tons, or practically 97 per cent, were properly mined either by hand or by the use of machines; for 2,029,800 tons the mining methods in practice were not reported, and shooting off the solid was responsible for only 626,295 short tons, or a little more than 1 per cent. This is a record of which the miners, the operators, and the mine-inspection service of the State Department of Mines may well be proud. If the methods of marketing and consuming West Virginia coal were as praiseworthy as the methods employed in its production, the Mountain State would hold an enviable position in industrial progress. It is also gratifying to note that although the coal production of West Virginia in 1911 was nearly 2,000,000 tons less than in 1910, the quantity of machine-mined tonnage showed a distinct gain from 27,981,617 short tons in 1910 to 29,121,480 tons in 1911. In 1910 the machine-mined coal represented 45.4 per cent of the total output; in 1911 it represented 48.7 per cent of the total. The number of mining machines in use in 1911 was 2,044 against 1,966 in 1910, an increase of 78. Nearly one-half the number of machines in use in 1911 (1,041 in all) was in the undercutters of the chain-breast pattern, and 667, or about one-third of the total number, were punchers. The long-wall machines numbered 77, the short-wall 253, and the post-radial acting machines 6.

With the exception of the counties in the "Pan Handle," or extreme northwestern part of the State, and one or two along Ohio River where the 8-hour rule obtains, most of the mines of West Virginia are operated 10 hours, though quite a large number are operated 9 hours.

Returns to the United States Bureau of Mines show that there were 350 fatal accidents in the coal mines of West Virginia in 1911. Of these 330 were under ground, 2 were in shafts, and 18 on the surface. The underground fatalities included 194 due to falls of roof or coal, 50 due to gas and dust explosions, 58 to haulageway accidents and 26 to miscellaneous causes. In the fiscal year ended June 10, 1910, there were 320 fatal accidents, compared with which the calendar year 1911 shows an increase of 24. The death rate in 1911 was 5.24, against 4.66 in the fiscal year 1910, and the number of tons mined for each life lost was 170,947 tons against 195,602.

The statistics of production by counties in 1910 and 1911 with the distribution of the product for consumption are shown in the following table:

Coal production of West Virginia in 1910 and 1911, by counties, in short tons.

1910.

County.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Made into coke.	Total quantity.	Total value.	Average price per ton.	Average number of days active.	Average number of employees.
Barbour	1,224,710	13,006	22,394	108,281	1,368,391	$1,036,659	$0.76	261	1,211
Braxton	164,773	1,761	589	....	167,123	146,556	.87	246	146
Brooke	461,551	5,589	3,534	....	470,674	482,886	1.03	278	594
Clay	33,443	6,193	4,966	....	44,602	49,371	1.11	194	76
Fayette	8,915,502	115,048	233,670	1,146,763	10,410,983	10,135,369	.97	219	13,501
Gilmer	41,440	3,526	224	....	45,190	38,200	.85	214	49
Grant	268,765	764	13,543	....	283,072	235,057	.83	245	341
Harrison	4,579,030	13,177	42,066	7,031	4,641,304	3,814,791	.80	222	4,368
Kanawha	6,792,490	101,782	91,915	24,300	7,010,487	6,518,055	.93	222	8,271
Lincoln	70,873	794	250	....	71,917	67,566	.94	254	122
Logan	2,846,936	15,642	33,750	....	2,896,328	2,657,097	.92	227	2,395
McDowell	9,915,587	176,305	250,859	3,145,325	13,488,076	12,767,998	.95	224	14,335
Marion	4,598,294	20,436	93,412	83,407	4,795,549	4,165,737	.87	244	4,171
Marshall	383,749	144,348	10,305	....	538,402	530,045	.98	232	569
Mason	195,428	21,388	4,401	....	221,217	203,906	.92	221	354
Mercer	2,291,338	29,846	46,161	509,489	2,876,834	2,603,126	.91	232	3,041
Mineral	874,258	5,192	4,136	....	883,586	798,609	.90	246	907
Mingo	2,380,206	22,274	40,150	....	2,442,630	2,170,289	.88	246	2,873
Monongalia	297,599	10,479	9,354	236,641	554,073	503,088	.91	279	480
Ohio	236,906	70,767	1,376	....	309,049	301,851	.98	272	371
Preston	717,578	7,772	23,175	415,857	1,164,382	856,866	.73	239	1,398
Putnam	522,181	7,599	10,852	....	540,632	612,001	1.13	262	979
Raleigh	3,249,937	32,637	64,555	....	3,347,129	3,309,678	.99	203	4,829
Randolph	405,950	7.806	7,085	180,066	600,907	481,840	.80	208	675
Taylor	694,110	5,794	5,890	13,436	719,230	525,660	.73	230	765
Tucker	1,025,674	6.832	35,125	250,336	1,317,967	1,184,590	.90	266	1,256
Upshur	84,291	6,201	2,268	....	92,760	70,007	.75	180	104
Other counties[a] and small mines.	289.919	70,956	4,637	3,013	368,525	398,163	1.08	241	482
Total	53,562,518	923,914	1,060,642	6,123,945	61,671,019	56,665,061	.92	228	68,663

1911.

County.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Made into coke.	Total quantity.	Total value.	Average price per ton.	Average number of days active.	Average number of employees.
Barbour	992,704	4,066	20,923	7,091	1,024,784	$758,417	$0.74	211	1,046
Boone	113,072	3,320	2,498	....	118,890	98,944	.83	121	257
Braxton	204,818	3,224	1,125	....	209,167	163,789	.78	222	177
Brooke	442,779	5,683	2,968	....	451,430	471,388	1.04	232	549
Clay	137,135	7,353	2,225	....	146,713	104,746	.71	201	176
Fayette	8,966,557	125,710	221,418	663,099	9,976,784	9,562,169	.96	225	13,050
Gilmer	48,160	4,972	448	....	53,580	44,300	.83	218	67
Harrison	4,175,796	18,000	47,302	....	4,241,098	3,154,222	.74	185	4,511
Kanawha	5,526,269	95,870	90,520	....	5,712,659	5,412,470	.95	207	7,392
Lincoln	81,050	720	....	....	81,770	75,356	.92	300	120
Logan	3,084,351	32,286	33,034	....	3,149,671	2,757,324	.88	218	2,701
McDowell	11,248,028	158,529	249,052	1,731,140	13,386,749	12,409,508	.93	238	12,792
Marion	4,602,497	23,257	109,523	95,263	4,830,540	4,051,397	.84	234	4,678
Marshall	515,287	153,773	9,112	....	678,172	644,127	.95	254	692
Mason	162,682	36,446	2,815	....	201,943	195,868	.97	229	308
Mercer	2,506,060	36,884	41.585	340,185	2,924,714	2,548,944	.87	218	2,895
Mineral	603,332	3,238	4.157	....	610,727	518,109	.85	189	821
Mingo	2,269,817	26,603	44.580	....	2,341,000	2,121,209	.91	235	3,318
Monongalia	294,445	4,415	8.609	188,188	495,657	401,429	.81	243	473
Ohio	251,836	72,709	1.650	....	326,195	317,837	.97	245	378
Preston	566,251	8,758	22,582	272,856	870,447	593,858	.68	191	1,131
Putnam	550.818	10,424	6,980	....	568,222	630,494	1.11	238	998
Raleigh	4,291,861	41,775	75,794	....	4,409,430	4,087,984	.93	229	4,648
Randolph	377,965	10,695	6,010	159,265	553,935	446,710	.81	192	495
Taylor	735,359	6,332	3,887	....	745,578	517,490	.69	204	830
Tucker	1,019.654	6,321	46,572	79,569	1,152,116	1,039,018	.90	218	1,502
Upshur	31,886	4,457	1,882	....	38,225	28,184	.74	151	55
Other counties[b] and small mines.	370,954	139,727	16,656	4,047	531,384	515,224	.97	154	670
Total	54,171,423	1,045,547	1,073,907	3,540,703	59,831,580	53,670,515	.90	221	66,730

[a] Boone, Greenbrier, Hancock, Lewis, Nicholas, Ritchie, Wayne, and Wood.
[b] Grant, Greenbrier, Hancock, Lewis, Nicholas, Ritchie, Wayne, and Webster.

The statistics of production by counties, during the last five years, with increase and decrease in 1911, as compared with 1910, are shown in the following table:

Coal production of West Virginia, by counties, 1907–1911, in short tons.

County.	1907	1908	1909	1910	1911	Increase (+) or decrease (−), 1911.
Barbour	1,175,763	1,023,029	1,024,805	1,368,391	1,024,784	− 343,607
Boone					118,890	+ 118,890
Braxton			105,714	167,123	209,167	+ 42,044
Brooke	454,119	433,373	380,887	470,674	451,430	− 19,244
Clay	63,747	6,622	43,212	44,602	146,713	+ 102,111
Fayette	8,599,978	7,663,561	9,877,521	10,410,983	9,976,784	− 434,199
Gilmer			40,201	45,190	53.580	+ 8,390
Grant	312,407	217,074	190,575	283,072	209,530	− 73,542
Hancock	87,100	85,631	75,633	71,211	49,200	− 22,011
Harrison	3,939,965	3,262,637	3,385,291	4,641,304	4,241,098	− 400,206
Kanawha	5,588,074	4,630,548	5,577,138	7,010,487	5,712,659	− 1,297,828
Lincoln			51,227	71,917	81,770	+ 9,853
Logan	1,248,522	1,683,456	2,147,965	2,896,328	3,149,671	+ 253,343
McDowell	9,840,975	8,601.802	11,964,836	13,488,076	13,386,749	− 101,327
Marion	4,228,231	3,922,398	4,195,473	4,795,549	4,830,540	+ 34,991
Marshall	612,605	259,769	356,619	538,402	678,172	+ 139,770
Mason	150,726	119.723	117,209	221,217	201,943	− 19,274
Mercer	2,344,426	2,088,343	2,511,000	2,876,834	2,924,714	+ 47,880
Mineral	746,668	696,226	892,245	883,586	610,727	− 272,859
Mingo	2,229,436	1,800,589	2,039,640	2,442,630	2,341,000	− 101,630
Monongalia	424,997	224,955	371,890	554,073	495,657	− 58,416
Nicholas	82,246	41,629	36,714	79,714	54,731	− 24,983
Ohio	187,545	145,987	236,870	309,049	326,195	+ 17,146
Preston	1,286,535	659,348	996,767	1,164,382	870,447	− 293,935
Putnam	437,073	532,446	575.009	540,632	568,222	+ 27,590
Raleigh	1,412,393	1,622,161	2,411,513	3,347,129	4,409,430	+ 1,062,301
Randolph	671,417	361,851	392,846	600,907	553,935	− 46,972
Taylor	475,237	489,069	483,906	719,230	745,578	+ 26,348
Tucker	1,217,267	980,425	1,157,753	1,317,967	1,152,116	− 165,851
Upshur			80,615	92,760	38,225	− 54,535
Other counties and small mines	274,131	345,191	128,146	217,600	217,923	+ 323
Total	48,091,583	41,897,843	51,849,220	61,671,019	59,831,580	− 1,839,439
Total value	$47,846,630	$40,009,054	$44,661,716	$56,665,061	$53,670,515	−$2,994,546

For commercial purposes the principal coal-producing regions of West Virginia may be divided into four distinct districts. These may be distinguished by certain geographic or physiographic features. They do not include all of the coal-producing counties of the State, but do include the more important ones, and they contribute over 90 per cent of the total output of the State. Two of these districts are in the northern portion of the State and two in the southern. The two in the northern portion are designated, respectively, the Fairmont or upper Monongahela district and the Elk Garden or upper Potomac; those in the southern portion of the State are the Pocahontas or Flat Top district and the New and Kanawha rivers district.

The upper Monongahela district is penetrated by the Baltimore & Ohio Railroad and sends its coal to market over that highway. The upper Potomac region also is reached by the Baltimore & Ohio Railroad and is penetrated by the Western Maryland Railway. The Pocahontas or Flat Top region is tributary to the main branch of the Norfolk & Western Railway. Most of the product of this district goes either west or to tidewater over that line. The New and Kanawha rivers district is named from the two rivers which drain it, the coal being shipped partly by the Chesapeake & Ohio Railway and the Kanawha & Michigan Railway, which pass through it, and partly by barges on Kanawha River. The Virginian Railway, to which reference has already been made, affords additional transportation to both the Pocahontas or Flat Top and the New River districts. The most important district in point of production is that of New and Kanawha rivers, which embraces the counties of Fayette, Kanawha, Raleigh, and Putnam. The coal from these four counties is drawn from two different areas, most of the coal from Kanawha and Putnam counties being from a higher geologic horizon than that of Fayette and Raleigh counties, but the district is practically compact and continuous and is drained by the same waters and reached by the same railroads, so the two areas are considered as one district in this report.

Coal production of the principal districts of West Virginia, 1886–1911, in short tons.

Year.	New and Kanawha Rivers district.[a]	Pocahontas, or Flat Top, district.[b]	Fairmont, or upper Monongahela, district.[c]	Upper Potomac, or Elk Garden, district.[d]
1886	2,290,563	968,484	406,976	383,712
1887	2,379,296	1,357,040	520,064	503,343
1888	2,840,630	1,912,695	473,489	518,878
1889	2,669,016	2,290,270	456,582	666,956
1890	3,012,414	2,702,092	600,131	819,062
1891	3,632,209	3,137,012	1,150,569	1,052,308
1892	3,773,021	3,503,260	1,141,430	942,154
1893	4,099,112	3,815,280	1,255,956	1,129,397
1894	3,650,971	5,059,025	1,655,532	927,220
1895	4,399,623	4,044,998	1,550,256	1,125,601
1896	4,650,455	4,608,113	1,743,590	1,245,012
1897	4,921,701	4,859,373	2,074,663	1,425,026
1898	5,947,272	5,521,160	2,525,294	1,531,562
1899	6,544,956	6,033,344	3,374,183	1,786,009
1900	7,804,879	6,901,637	4,187,630	1,999,797
1901	8,427,574	6,736,107	5,174,160	1,856,677
1902	7,089,805	7,431,687	5,463,791	2,581,218
1903	9,843,063	8,319,775	5,638,337	2,229,065
1904	11,429,403	10,858,159	7,937,845	1,858,197
1905	13,474,282	13,378,468	8,491,165	1,878,279
1906	14,953,677	14,621,316	10,686,659	2,158,005
1907	16,183,511	16,779,893	11,530,728	2,276,342
1908	14,496,967	15,154,204	9,581,436	1,893,725
1909	18,521,107	19,639,106	10,458,132	2,240,573
1910	21,433,547	22,891,014	13,242,929	2,484,625
1911	20,928,539	23,083,358	12,217,104	1,972,373

[a] Includes Clay, Fayette, Kanawha, Nicholas, Putnam, and Raleigh counties.
[b] Includes Logan McDowell, Mercer, and Mingo counties, and Tazewell County, Va.
[c] Includes Barbour, Harrison, Marion, Monongalia, Preston, and Taylor counties.
[d] Includes Grant, Mineral, and Tucker counties.

The statistics of coal production in West Virginia since 1863, when the State was formed out of Virginia, to the close of 1911 are shown in the following table:

Production of coal in West Virginia, 1863–1911, in short tons.

Year.	Quantity.	Year.	Quantity.	Year.	Quantity.	Year.	Quantity.
1863	444,648	1876	896,000	1889	6,231,880	1902	24,570,826
1864	454,888	1877	1,120,000	1890	7,394,654	1903	29,337,241
1865	487,897	1878	1,120,000	1891	9,220,665	1904	32,406,752
1866	512,068	1879	1,400,000	1892	9,738,755	1905	37,791,580
1867	589,360	1880	1,829,844	1893	10,708,578	1906	43,290,350
1868	609,227	1881	1,680,000	1894	11,627,757	1907	48,091,583
1869	603,148	1882	2,240,000	1895	11,387,961	1908	41,897,843
1870	608,878	1883	2,335,833	1896	12,876,296	1909	51,849,220
1871	618,830	1884	3,360,000	1897	14,248,159	1910	61,671,019
1872	700,000	1885	3,369,062	1898	16,700,999	1911	59,831,580
1873	1,000,000	1886	4,005,796	1899	19,252,995		
1874	1,120,000	1887	4,881,620	1900	22,647,207	Total.	649,448,201
1875	1,120,000	1888	5,498,800	1901	24,068,402		

WYOMING.

Total production in 1911, 6,744,864 short tons; spot value, $10,508,863.

In common with the majority of the States in the Rocky Mountain region the coal production of Wyoming was considerably smaller than in 1910, but with the exception of 1910, when the record output was obtained, the tonnage won in 1911 was larger than in any other preceding year. Compared with 1909 the output in 1911 showed a normal increase. Coal mining in all the Rocky Mountain States was abnormally stimulated in 1910 by the strike among the miners of the Middle Western States. Wyoming's production increased more than 1,100,000 tons over 1909 and reached a total of 7,533,088 short tons. With the return to normal conditions in 1911 the production in Wyoming fell off to 6,744,864 short tons, a decrease of 788,224 short tons, or 10.5 per cent. The value declined from $11,706,187 to $10,508,863, a decrease of $1,197,324, or 10.2 per cent. The small difference in the percentage of decrease between quantity and value was not due to any actual advance in price. There was a general decline in values for commercial coal in most of the coal-producing regions, but in Carbon and Sweetwater counties, where a large part of the product is mined for railroad use by companies affiliated with the transportation interests, the prices were apparently somewhat higher.

According to the returns there was an increase in the number of men employed in 1911 over 1910, but there were fewer days worked. In 1910, 7,771 men were employed for the unusually large average of 248 days; in 1911 the number of men employed was 7,924 and the average number of working days was 230. The average production for each man employed was 851 short tons in 1911, against 969 tons in 1910. The average daily production per man decreased from 3.91 to 3.7 tons.

The quantity of coal undercut by machines in 1911 was 1,948,589 short tons, or 28.9 per cent of the total output, against 1,468,994 short tons, or 19.5 per cent of the total, in 1911. The number of machines reported in use in 1911 was 155, of which 55 were of the puncher type, 75 were chain breast, 2 were cutter bar, 12 were shortwall or continuous-cutter machines, 1 was long wall, and 10 were of the post-puncher or radialaxe type. In 1910 the number of mining machines reported was 98, and the machine-mined product amounted to 1,468,994 tons.

Companies whose aggregate production amounted to 6,588,852 short tons reported in 1911 that 1,956,941 tons, or 29 per cent, were mined by hand, and that 2,683,322 tons, or 39.8 per cent, were shot off the solid, the remainder being the 1,948,589 tons mined by machines.

Wyoming's coal-mining death roll in 1911, according to the United States Bureau of Mines, was 33. The rate per thousand was 4.16, and the coal mined for each life lost was 204,390 short tons. Of the total fatal accidents, 31 were underground and of these all but 5 were due to falls of roof and coal.

Coal production of Wyoming in 1910 and 1911, by counties, in short tons.

County.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Total quantity.	Total value.	Average price per ton.	Average number of days active.	Average number of employees.
1910.								
Bighorn	170,315	5,644	5,300	181,259	$303,728	$1.68	206	197
Carbon	638,731	6,802	20,126	665,659	1,030,874	1.55	283	627
Converse	5,400	2,000	1,550	8,950	16,500	1.84	193	56
Sheridan	1,246,202	21,313	35,839	1,303,354	1,645,024	1.26	203	1,457
Sweetwater	2,785,089	12,902	77,458	2,875,449	4,710,977	1.64	261	2,952
Uinta	1,824,044	22,430	114,197	1,960,671	3,017,673	1.54	249	1,966
Other counties [a]	490,551	15,228	29,738	535,517	976,113	1.82	278	516
Small mines		2,229		2,229	5,298	2.38		
Total	7,160,332	88,548	284,208	7,533,088	11,706,187	1.55	248	7,771
1911.								
Carbon	571,712	8,770	17,014	597,496	$946,017	$1.58	275	576
Converse	14,205	587	2,200	16,992	29,347	1.73	130	80
Sheridan	1,095,022	20,910	24,534	1,140,466	1,372,132	1.20	236	1,139
Sweetwater	2,543,106	13,209	71,887	2,628,202	4,522,504	1.72	227	3,290
Uinta	1,584,007	22,965	118,339	1,725,311	2,563,109	1.49	233	2,040
Other counties [b]	578,884	15,024	40,022	633,930	1,069,281	1.69	197	799
Small mines		2,467		2,467	6,473	2.62		
Total	6,386,936	83,932	273,996	6,744,864	10,508,863	1.56	230	7,924

[a] Crook, Fremont, Johnson, Park, and Weston.
[b] Bighorn, Crook, Fremont, Johnson, Park, and Weston.

The statistics of the production of coal, by counties, during the last five years, with increase and decrease in 1911 as compared with 1910, are shown in the following table:

Coal production of Wyoming, 1907–1911, by counties, in short tons.

County.	1907	1908	1909	1910	1911	Increase (+) or decrease (−), 1911.
Bighorn	56,966	101,275	133,389	181,259	172,884	−8,375
Carbon	583,402	543,009	590,969	665,659	597,496	−68,163
Converse	48,700	32,745	16,885	8,950	16,992	+8,042
Sheridan	1,226,221	839,533	970,165	1,303,354	1,140,466	−162,888
Sweetwater	2,071,842	2,180,933	2,641,860	2,875,449	2,628,202	−247,247
Uinta	1,889,742	1,380,488	1,586,320	1,960,671	1,725,311	−235,360
Weston	361,015	337,815	354,182	416,714	325,114	−91,600
Crook Fremont Johnson	14,362	73,170	[a] 91,751	[a] 118,803	[a] 135,932	+17,129
Small mines	740	934	7,588	2,229	2,467	+238
Total	6,252,990	5,489,902	6,393,109	7,533,088	6,744,864	−788,224
Total value	$9,732,668	$8,868,157	$9,896,848	$11,706,187	$10,508,863	−$1,197,324

[a] Crook, Fremont, Johnson, and Park.

The first production of coal in Wyoming was reported in 1865, one year later than the first reported output of coal in Colorado. This pioneer coal mining was probably carried on in connection with the construction of the Union Pacific Railroad. The total output in that year amounted to 800 tons. Five years later, when the railroad was completed, the production amounted to about 50,000 tons.

The growth of the coal-mining industry, indicating, as it does, the increase in population and in industrial development of the State since 1865 and up to the close of 1911, is shown in the following table:

Production of coal in Wyoming from 1865 to 1911, in short tons.

Year.	Quantity.	Year.	Quantity.	Year.	Quantity.	Year	Quantity.
1865	800	1878	333,200	1891	2,327,841	1904	5,178,556
1866	2,500	1879	400,991	1892	2,503,839	1905	5,602,021
1867	5,000	1880	589,595	1893	2,439,311	1906	6,133,994
1868	6,925	1881	420,000	1894	2,417,463	1907	6,252,990
1869	49,382	1882	707,764	1895	2,246,911	1908	5,489,902
1870	50,000	1883	779,689	1896	2,229,624	1909	6,393,109
1871	147,328	1884	902,620	1897	2,597,886	1910	7,533,088
1872	221,745	1885	807,328	1898	2,863,812	1911	6,744,864
1873	259,700	1886	829,355	1899	3,837,392		
1874	219,061	1887	1,170,318	1900	4,014,602	Total	103,979,728
1875	300,808	1888	1,481,540	1901	4,485,374		
1876	334,550	1889	1,388,947	1902	4,429,491		
1877	342,853	1890	1,870,366	1903	4,635,293		

RECENT PUBLICATIONS OF THE UNITED STATES GEOLOGICAL SURVEY RELATING TO COAL, COKE, LIGNITE, AND PEAT.

Compiled by John M. Nickles.

The following is a list of the more important papers dealing with coal, coke, lignite, and peat, published by the United States Geological Survey since the preparation of the bibliography published in Mineral Resources of the United States for 1910. This supplementary list, like the complete list in the report for 1910, deals with the geologic work in the several States alphabetically arranged.

ALASKA.

The Bonnifield region, Alaska, by S. R. Capps. Bull. 501, 1912, pp. 54-62.

COLORADO.

The coal resources of Gunnison Valley, Mesa and Delta counties, Colo., by E. G. Woodruff. Bull. 471, 1912.

Coal fields of Grand Mesa and the West Elk Mountains, Colo., by W. T. Lee. Bull. 510, 1912.

ILLINOIS.

Geology and mineral resources of the Peoria quadrangle, Illinois, by J. A. Udden. Bull. 506, 1912, pp. 80-89.

MONTANA.

The southern extension of the Milk River coal field, Chouteau County, Mont., by L. J. Pepperberg. Bull. 471, 1912.

The Electric coal field, Park County, Mont., by W. R. Calvert. Bull. 471, 1912.

The Livingston and Trail Creek coal fields, Park, Gallatin, and Sweetgrass counties, Mont., by W. R. Calvert. Bull. 471, 1912.

The Culbertson lignite field, Valley County, Mont., by A. L. Beekly. Bull. 471, 1912.

The Sidney lignite field, Dawson County, Mont., by Eugene Stebinger. Bull. 471, 1912.

The Terry lignite field, Custer County, Mont., by F. A. Herald. Bull. 471, 1912.

The Glendive lignite field, Dawson County, Mont., by J. H. Hance. Bull. 471, 1912.

The Baker lignite field, Custer County, Mont., by C. F. Bowen. Bull. 471, 1912.

Geology of certain lignite fields in eastern Montana, by W. R. Calvert. Bull. 471, 1912.

NEW MEXICO.

The Tijeras coal field, Bernalillo County, N. Mex., by W. T. Lee. Bull. 471, 1912.

NORTH CAROLINA.

Coal on Dan River, North Carolina, by R. W. Stone. Bull. 471, 1912.

NORTH DAKOTA.

Lignite in the Fort Berthold Indian Reservation, North Dakota, north of Missouri River, by M. A. Pishel. Bull. 471, 1912.

Bismarck folio, North Dakota, description by A. G. Leonard. Geol. Atlas U. S., folio 181, 1912, pp. 6–7.

PENNSYLVANIA.

Foxburg-Clarion folio, Pennsylvania, description by E. W. Shaw and M. J. Munn. Geologic Atlas U. S., folio 178, 1911, pp. 12–13 (field edition, pp. 97–103).

Claysville folio, Pennsylvania, description by M. J. Munn. Geologic Atlas U. S., folio 180, 1912, pp. 12–13.

SOUTH DAKOTA.

Coal near the Black Hills, Wyoming-South Dakota, by R. W. Stone. Bull. 499, 1912, 66 pp.

UTAH.

The Deep Creek district of the Vernal coal field, Uintah County, Utah, by C. T. Lupton. Bull. 471, 1912.

The Blacktail (Tabby) Mountain coal field, Wasatch County, Utah, by C. T. Lupton. Bull. 471, 1912.

WYOMING.

The Sussex coal field, Johnson, Natrona, and Converse counties, Wyo., by C. H. Wegemann. Bull. 471, 1912.

The Little Powder River coal field, Campbell County, Wyo., by J. A. Davis. Bull. 471, 1912.

Coal fields of the Wind River region, Fremont and Natrona counties, Wyo., by E. G. Woodruff and D. E. Winchester. Bull. 471, 1912.

The Lost Spring coal field, Converse County, Wyo., by D. E. Winchester. Bull. 471, 1912.

Coal near the Black Hills, Wyoming-South Dakota, by R. W. Stone. Bull. 499, 1912, 66 pp.

TECHNOLOGIC.

Miscellaneous analyses of coal samples from various fields of the United States. Bull. 471, 1912.

COKE.

By Edward W. Parker.

INTRODUCTION.

The most striking feature connected with the coke-making industry of the United States in 1911 was the relative advance in the construction and operation of retort or by-product ovens, for whereas, in sympathy with the depression in the iron trade, the total production of coke decreased 15 per cent as compared with 1910, the output from by-product ovens increased 10 per cent, and the increase in the number of this type of oven in operation was larger than in any year since it was introduced into the United States, the increase of 1904 over 1903 excepted.

Coke, as considered in this and the preceding chapters of the series, is the product obtained by subjecting certain grades of bituminous coal to high temperatures in chambers from which either the air is entirely excluded or into which only a sufficient quantity of air is admitted to secure, supposedly, the combustion of the volatile contents of the coal. The process, consequently, is one either of distillation or of partial combustion. When the process is one of distillation, the coal, usually crushed to one-half inch or smaller, is charged into chambers or retorts approximately 30 feet long, 6 to 8 feet high, and from 17 to 22 inches wide, the heat being applied by the combustion, in flues arranged vertically or horizontally between the coking chambers, of gases distilled from the coal. Such coking chambers or ovens are known as retort ovens and are usually, but not always, designed for the recovery of the by-products of tar and ammonia and of the "surplus" gas; that is, the gas over and above that required for the heating of the ovens. The common coke-making practice in the United States has been that of partial combustion in ovens having the shape of the conventional beehive and to which the name of beehive oven has been given. The beehive oven is an arched circular chamber usually 12 or 13 feet in diameter, 6 or 7 feet high in the center, and about 3 feet high at the circumference. It holds a charge of from 6 to 8 tons of coal. In this type of oven no attempt is made to recover any of the constituents of the coal except the fixed carbon or coke, though in isolated instances the burning gases have been utilized for the generation of heat, light, and power. During the last few years a new type of oven has been meeting with favor in some of the coking districts. It is a modification of the beehive oven, but instead of being built in circular form, like the beehive oven, is of rectangular construction and of such dimensions that the coke may be pushed instead of drawn from the coking chambers. At the close of 1911 there were 2,524 ovens of this type in operation and 200 in the course of construction.

The coke product obtained in either the distillation or the partial-combustion process is a fuel suitable for the blast furnace, the foundry, and the smelter, although its use is not restricted to these industries. A considerable portion of the coke manufactured in the United States is crushed in the same manner as anthracite, screened, and sold for domestic consumption. It is a smokeless fuel, and thus becomes a competitor with anthracite in cities where the emission of smoke from the combustion of bituminous coal is prohibited. It also comes into competition with gas-house coke and with both natural and manufactured gas. The coke product resulting from the manufacture of illuminating gas, which is accomplished in small retorts in which the process is conducted at much lower temperatures than in either beehive or retort ovens, is not considered in this report.

Although noteworthy progress has been made in the substitution of modern retort-oven practice for the wasteful and what should be obsolete beehive or partial-combustion method of coke making in the United States, this country is still much behind European countries in this regard. In Belgium and in Germany, two of the principal coke-making countries of continental Europe, beehive ovens have long since been abandoned, and all of the coke is made in retorts with or without recovery of by-products. When the by-products are not recovered the oven gases in excess of the quantity required for the heating of the ovens are used in the power houses. The quantity of power derivable from each oven varies from 15 to 20 horsepower per hour. The yield of coal in coke in retort ovens exceeds that obtained in beehive or other partial-combustion ovens by about 15 per cent, and generally the quality of the coke is improved.

All of the retort ovens thus far constructed in the United States are of the by-product recovery type, but some beehive plants, notably one at Dawson, N. Mex., have been equipped with flues conducting the heated gases to the power house and utilizing them in the same manner as is accomplished with the nonrecovery retort oven. The economies effected in the operation of beehive ovens in this way are stated to be largely offset by the expenses necessary for repairs.

The by-product recovery branch of the coking industry in the United States began in 1893, when a plant of 12 Semet-Solvay ovens was completed at Syracuse, N. Y., which has since been increased to 40 ovens. The first plant of Otto-Hoffmann (now known as ''United Otto'') ovens was built at Johnstown, Pa., in 1895. It consisted of 60 ovens. This plant has been enlarged three times and now contains 372 ovens. From the small beginnings in 1893 and 1895 the number of plants and of ovens have increased until at the close of 1911 there were 29 by-product recovery plants, with a total of 4,624 ovens, and there were 5 plants and a total of 698 retort ovens under construction. During the last two years there has been a marked revival in the construction of by-product recovery coke plants, and more ovens were under construction in 1909, 1910, and 1911 than in any year since 1903.

All of the coke produced in retort ovens is a fuel suitable for metallurgical purposes, but its use, like beehive coke, is not restricted to the metallurgical industries. Where the retort ovens are located at iron or steel plants the coke may be considered the primary product and is used almost exclusively in the blast furnaces. Where the ovens are located in or near large cities, the coke becomes a secondary product, some of it being used in metallurgical operations and some in manufacturing, or by railroads, or for domestic consumption. The location of the plant rather than the quality of the coke determines whether the coke product is primary or secondary; but as it is impossible to make any accurate separation of the uses to which the coke is put, the entire production is included in the statistics, as compiled by the United States Geological Survey. The details of the production of coke in retort ovens are discussed more fully in the subsequent pages of this report.

The coal consumed in the manufacture of coke in the United States is drawn from the following bituminous regions or fields:

1. The Appalachian region, embracing the great coking coal fields of Pennsylvania, Virginia, West Virginia, Ohio, eastern Kentucky, Tennessee, Alabama, and Georgia.
2. The eastern interior region, which includes the coal fields of Illinois, Indiana, and western Kentucky.
3. The western interior region, embracing the States of Iowa, Kansas, Missouri, Nebraska, Oklahoma, and Arkansas.
4. The Rocky Mountain region, contained within the States of Colorado, New Mexico, Utah, Montana, and Wyoming.
5. The Pacific coast region, in which the only coking coals are found in the State of Washington.

The coal of the northern interior region lying wholly within the State of Michigan has not been used in the manufacture of coke. A considerable quantity of coke is made in States in which there are no coal fields—Massachusetts, Minnesota, New York, New Jersey, and Wisconsin. The ovens near Baltimore, Md., and at Delray and Wyandotte, Mich., are supplied with coal from other States. One of the two plants in Wisconsin is composed of beehive ovens in which coal drawn from the mines of Pennsylvania is used. This is the only beehive plant in operation outside of the coal-producing States. Some of the ovens in Ohio, Indiana, and Illinois, though in coal-mining States, draw their supplies of coking coal from West Virginia. All of the other coking establishments outside of the States producing coking coal are retort-oven plants.

The unit of measurement used in this chapter is uniformly the short ton of 2,000 pounds.

PRODUCTION.

STATISTICS OF PRODUCTION IN 1911.

The total production of retort and oven coke in the United States in 1911 amounted to 35,551,489 short tons, valued at $84,130,849, the smallest output in both quantity and value, except in the panic year of 1908, since 1905. Compared with 1910, when the production amounted to 41,708,810 short tons (the maximum output), valued at $99,742,701, the record for 1911 shows a decrease of 6,157,321 short tons, or 14.8 per cent, in quantity, and of $15,611,852, or 15.6 per cent, in value. The average price per ton declined from $2.39 in 1910 to $2.37 in 1911. The highest price for coke in recent years and the maximum value of the product in any year was in the boom year 1907, when the total value amounted to $111,539,126 and the average price per ton was $2.74. The value of the coal used in making coke in 1911 was relatively more compared with the value of the coke made than it was in 1910, the average value per ton of the coal used advancing from $1.19 to $1.20 and that of coke declining from $2.39 to $2.37. The average price per ton for the coke in both years, as the figures show, was almost exactly double that of the coal used. The quantity of coal used in the manufacture of coke in 1910 was 63,088,327 short tons, valued at $74,846,393; in 1911 the quantity of coal used was 53,278,248 tons, valued at $64,112,084.

The production of coke in 1911 consisted of 27,703,644 tons of oven coke, valued at $56,832,952, and of 7,847,845 tons of retort or by-product coke, valued at $27,297,897. In 1910 the production of oven coke was 34,570,076 tons and that of retort or by-product coke was 7,138,734 tons. From this it appears that the output of oven coke decreased 6,866,432 tons, or 19.86 per cent, while that of by-product coke increased 709,111 tons, or 9.9 per cent. The percentage of by-product coke to the total output has increased from 15.91 per cent in 1909 to 17.12 per cent in 1910 and to 22.07 per cent in 1911. The average price per ton for oven coke in 1911 was $2.05 and that for retort coke was $3.48; in 1910 these average prices were, respectively, $2.17 and $3.47, showing that the decreased production of oven coke was attended by a decline in price and that the increased production of by-product coke was attended by an advance in price. The value of retort coke is always higher than that of oven coke for the reason that the retort ovens are located near the centers of consumption where the markets for coke as well as for gas and other by-products are available. They are consequently at a distance from the mines and the expenses of transportation are borne by and added to the cost of the coal, whereas the beehive and other nonrecovery ovens are for the most part located immediately at the mines and the transportation charges are borne by the coke.

In considering the total value and the average selling price for the coke produced in the United States, it should be remembered that many of the coke ovens in this country are operated by large corporations, which operate also coal mines and blast furnaces, the coke making being really only an incidental part of the business. In such cases the coke product is sometimes charged against the furnace department at cost and sometimes at a figure based upon the cost of coal mining and coke making, plus a percentage of profit on these operations. The value is not fixed by the market price. In other cases the value is estimated upon the average prices for coke of a similar quality produced and sold in the immediate vicinity. These conditions, however, continue from year to year and do not affect comparisons.

The coal consumed in the manufacture of coke in 1911 amounted, as previously stated, to 53,278,248 short tons, valued at $64,112,084. The value of the coke produced from the coal was $84,130,489. The difference between the value of the coal used and the coke produced was $20,018,765, which, less the cost of manufacture, expenses of administration, etc., represented the profit on the coke-making operations. In 1910 the value of the coal used was $74,846,393, and the value of the coke produced was $99,742,701, a difference of $24,896,308 Relatively these differences were about the same, as the percentage o difference in the average prices per ton of coal used and of coke produced in 1910 and 1911 was the same.

With the exception of 1908, there have been few years in recen history that have been more unsatisfactory to the producers of coke Notwithstanding that a large number of ovens were out of blast during the entire year and that the production was curtailed by 15 per cent the offerings of coke on the market were generally in excess of demand

and prices were at a number of times during the year at a lower level even than in 1908. "Spot" Connellsville furnace coke sold as low as $1.40 per short ton, with $1.65 as the highest point reached, except for the last week in December, when the shutdown for the holidays caused a brief scarcity in the supply and quotations for spot coke advanced from $1.75 to $1.80. In making contracts for future deliveries manufacturers held out for better figures and prices for future delivery were quoted during the first few months of the year at from 30 cents to 45 cents above what the producers were able to obtain for spot coke. As the year wore on, however, with only a temporary improvement during April, even contract prices sagged and at the close of the year contracts were made at from 10 to 15 cents above the spot figures. Connellsville coke is recognized as the standard for blast furnace use. Other cokes competing with it were subject to as great, if not greater, demoralization in values.

The year 1911 was notable for the large number of ovens idle during the year and for the number of plants and of ovens abandoned. Altogether there were 18 plants, with a total of 973 ovens, that were abandoned, and only 10 new plants were completed. The total number of idle ovens was the largest in the history of the industry, and with the exception of 1908 there were fewer ovens in the course of construction at the close of 1911 than in any year since 1899.

The total number of ovens decreased from 104,440 in 1910 to 103,879 in 1911, a loss of 561, and there were 2,254 ovens in course of construction at the end of the year. Of the 103,879 ovens in existence at the close of 1911, 40,399 were idle throughout the year. The number of idle ovens does not include those that were idle for a portion of the year only. In 1910, of the 104,440 ovens in existence, 8,373 were idle throughout the year. The number of ovens in blast during the whole or a portion of the year 1911 was 63,480, of which 59,160 were beehive, or partial combustion, ovens, and 4,320 were retort, or distillation, ovens. The 59,160 beehive ovens produced a total of 27,703,644 short tons, or an average of 468 tons for each active oven. Of the 4,624 by-product recovery ovens in existence at the close of 1911, 304 were idle throughout the year, leaving 4,320 ovens that made coke during 1911. The total production of the 4,320 active retort ovens was 7,847,845 short tons, or an average of 1,817 tons per oven, as compared with 468 tons as the average production of the beehive ovens. The average value per oven of the coke produced in beehive ovens was $961, and the average value per oven of the coke and the by-products produced in retort ovens was $8,642, about nine times the average value of the beehive production.

At the close of 1911 there were 2,254 ovens in course of construction. Of the ovens building, 698, or 30.97 per cent, were by-product recovery ovens. The 698 retort ovens under construction in 1911 consisted of 70 Koppers ovens building by the Illinois Steel Co. at Gary, Ind.; 35 Koppers ovens building by the Coal Products Manufacturing Co. at Joliet, Ill.; 280 of the same type building for the Tennessee Coal, Iron & Railroad Co. at Corey, Ala.; 300 Didier ovens building by the Lehigh Coke Co. at South Bethlehem, Pa; and 13 Semet-Solvey ovens building by the North Shore Gas Co. at Waukegan, Ill. The Didier ovens will furnish coke for the Bethlehem Steel Co. works at South Bethlehem, Pa.

Considering each bank of ovens as a separate establishment, the returns for 1911 show a total of 570 establishments in that year, against 578 in 1910, a decrease of 8. There were 19 plants abandoned and dismantled in 1911, and 10 new ones were constructed. Of the 570 establishments in 1911, 179 establishments and a total of 15,983 ovens were idle throughout the year, compared with 100 establishments idle in 1910 and 105 in 1909. The idle establishments were mostly small ones. The average number of ovens to the idle establishments in 1911 were 89; the average to the active establishments was nearly 225 ovens.

The statistics of the production of coke in 1910 and 1911 are presented, by States, in the following table:

Manufacture of coke, by States, in 1910 and 1911.

State.	Establishments.	Ovens.		Coal used (short tons).	Yield of coal in coke (per cent).	Coke produced (short tons).	Total value of coke.	Price of coke per ton.
		Built.	Building.					
1910.								
Alabama	43	10,132	340	5,272,322	61.6	3,249,027	$9,165,821	$2.82
Colorado [a]	16	3,611	0	2,069,266	65.1	1,346,211	4,273,579	3.17
Georgia	2	350	0	80,019	54.8	43,814	173,049	3.95
Illinois	5	508	0	1,972,955	76.8	1,514,504	6,712,550	4.43
Kentucky	6	495	0	104,103	51.7	53,857	120,554	2.24
Missouri	1	4	0	0	....	0	0	....
New York	4	556	0	910,293	71.7	652,459	2,635,873	4.04
New Mexico	4	1,030	0	651,494	61.6	401,646	1,306,136	3.25
Ohio	8	496	0	413,059	68.3	282,315	911,987	3.23
Pennsylvania	288	55,656	1,334	39,455,785	66.7	26,315,607	55,254,599	2.10
Tennessee	16	2,792	0	597,658	54.0	322,756	959,104	2.97
Utah	2	854	0	(b)	....	(b)	(b)	....
Virginia	18	5,389	100	2,310,742	64.6	1,493,655	2,731,348	1.83
Washington	6	285	0	94,223	63.0	59,337	347,540	5.86
West Virginia	135	19,912	230	6,226,234	61.1	3,803,850	7,354,039	1.93
Indiana Kansas Maryland Massachusetts Michigan Minnesota Montana New Jersey Oklahoma Wisconsin	24	2,370	563	2,930,174	74.4	2,169,772	7,796,522	3.59
Total	578	104,440	2,567	63,088,327	66.1	41,708,810	99,742,701	2.39
1911.								
Alabama	44	10,121	280	4,411,298	62.6	2,761,521	$7,593,594	$2.75
Colorado [a]	16	3,606	0	1,810,335	65.0	1,177,023	3,880,710	3.30
Georgia	2	225	0	72,677	51.7	37,553	135,190	3.60
Kentucky	8	577	300	118,255	55.9	66,099	134,862	2.04
New Mexico	4	1,030	0	620,639	61.5	381,927	1,240,963	3.25
New York	4	556	0	955,067	71.8	686,172	2,883,990	4.20
Ohio	8	496	0	456,222	68.2	311,382	961,904	3.09
Pennsylvania	279	54,904	1,271	32,875,655	66.7	21,923,935	43,053,367	1.96
Tennessee	15	2,547	30	628,118	52.6	330,418	797,758	2.41
Utah	2	854	0	(b)	(b)	(b)	(b)	....
Virginia	18	5,496	100	1,425,303	63.9	910,411	1,615,609	1.77
Washington	5	235	0	60,201	66.6	40,180	216,262	5.38
West Virginia	138	19,876	130	3,754,561	60.4	2,291,049	4,236,845	1.85
Illinois Indiana Kansas Maryland Massachusetts Michigan Minnesota Montana New Jersey Oklahoma Wisconsin	27	3,356	143	6,089,917	75.4	4,633,819	17,379,795	3.75
Total	570	103,879	2,254	53,278,248	66.7	35,551,489	84,130,849	2.37

[a] Includes production of Utah.

[b] Production included with Colorado.

PRODUCTION IN PREVIOUS YEARS.

The earliest record of the quantity of coke produced in the United States is contained in the report of the Tenth United States Census (1880), in which year the production is stated to have been 3,338,300 short tons. The Seventh Census (1850) reported four establishments engaged in the manufacture of coke, but gave no figures of production, and none was reported by either the Eighth or the Ninth Census, although coke making was even at that period in our history of some importance as a manufacturing industry, for in 1875, according to James M. Swank, general manager of the American Iron and Steel Association, the quantity of pig iron made with coke exceeded that made with anthracite coal, the latter having held the supremacy over charcoal for 20 years. At the present time the use of anthracite for blast furnaces is negligible.

In preparing the report on the manufacture of coke in 1882 for the first volume of this series, the late Joseph D. Weeks also obtained the statistics of production for 1881, so that with the close of 1911 there is a complete record for 32 years. As shown in the following table, coke making has kept pace with our industrial progress in other lines, especially with the growth in iron manufacture and in railroad construction. At the taking of the Eleventh Census in 1890 the production of coke was a little more than three times the quantity reported in 1880 and amounted to 11,508,021 short tons. By 1900 it had almost doubled that of 1890, the production in that year being 20,533,348 short tons. In 1910, the year of maximum record, the production had more than doubled again, being 41,708,810 short tons. During this period of 32 years there have been 9 years of decreased production, as compared with the year immediately preceding, the most pronounced instances being in the panic years of 1893 and 1894 and in the business depression of 1908.

In the following table is presented a statement of the quantity of coke produced in the United States in each year since 1880:

Quantity of coke produced in the United States, 1880–1911, in short tons.

1880	3,338,300	1891	10,352,688	1902	25,401,730
1881	4,113,760	1892	12,010,829	1903	25,274,281
1882	4,793,321	1893	9,477,580	1904	23,661,106
1883	5,464,721	1894	9,203,632	1905	32,231,129
1884	4,873,805	1895	13,333,714	1906	36,401,217
1885	5,106,696	1896	11,788,773	1907	40,779,564
1886	6,845,369	1897	13,288,984	1908	26,033,518
1887	7,611,705	1898	16,047,209	1909	39,315,065
1888	8,540,030	1899	19,668,569	1910	41,708,810
1889	10,258,022	1900	20,533,348	1911	35,551,489
1890	11,508,021	1901	21,795,883		

Although the total production of coke in 1911 was less than that of 1910 by more than 6,000,000 short tons, there were 7 States in which increased production was shown. The principal increase was in Indiana and was due to the fact that a portion of the plant of Koppers ovens (490 out of 560), at Gary, was completed and put in blast by the United States Steel Corporation. The production of Illinois was also increased by the operations of the Koppers ovens at

Joliet. Both of these plants draw their coking coal from West Virginia mines, mixing this with Illinois coal in proportions of 4 to 1 with satisfactory results. The increases in the other five States, Kansas, Kentucky, New York, Ohio, and Tennessee, were unimportant, aggregating less than 70,000 tons. The largest decrease was in Pennsylvania, whose output in 1911 was less by 4,391,672 tons, or 16.7 per cent, than in 1910. West Virginia was second in decreased tonnage (1,512,801 tons), and suffered the largest percentage of decrease (39.8 per cent). Virginia closely followed West Virginia in percentage of decrease with 39.5 per cent, the quantity of coke made in Virginia in 1911 being 583,244 tons less than in 1910. Alabama's production fell off 487,506 tons, or 15 per cent, and the combined output of Colorado and Utah decreased 169,188 tons, or 12.6 per cent.

In the following table is shown the production of coke by States during the last five years, with the increases and decreases in 1911 as compared with 1910:

Quantity of coke produced in the United States, 1907–1911, by States, in short tons, with increase and decrease in 1911.

State.	1907	1908	1909	1910	1911	Increase (+) or decrease (−) in quantity of coke produced.	
						1910–11	Per cent.
Alabama	3,021,794	2,362,666	3,085,824	3,249,027	2,761,521	− 487,506	−15.0
Colorado [a]	1,421,579	982,291	1,251,805	1,346,211	1,177,023	− 169,188	−12.6
Georgia	74,934	39,422	46,385	43,814	37,553	− 6,261	−14.2
Illinois	372,697	362,182	1,276,956	(b)	(b)	(b)	(b)
Kansas	6,274	2,497	....	(b)	(b)	(b)	(b)
Kentucky	(b)	(b)	46,371	53,857	66,099	+ 12,242	+22.7
Montana	(b)	(b)	(b)	(b)	....	....	....
New Mexico	265,125	274,565	373,967	401,646	381,927	− 19,719	− 4.9
New York	(b)	(b)	(b)	652,459	686,172	+ 33,713	+ 5.2
Ohio	270,634	159,578	222,711	282,315	311,382	+ 29,067	+10.3
Oklahoma (Indian Territory)	(b)	(b)	....	(b)	....	....	....
Pennsylvania	26,513,214	15,511,634	24,905,525	26,315,607	21,923,935	−4,391,672	−16.7
Tennessee	467,499	214,528	261,808	322,756	330,418	+ 7,662	+ 2.4
Utah	(c)	(c)	(c)	(c)	(c)	(c)	(c)
Virginia	1,545,280	1,162,051	1,347,478	1,493,655	910,411	− 583,244	−39.5
Washington	52,028	38,889	42,981	59,337	40,180	− 19,157	−32.3
West Virginia	4,112,896	2,637,123	3,943,948	3,803,850	2,291,049	−1,512,801	−39.8
Other States	2,655,610	2,286,092	2,509,306	3,684,276	4,633,819	+ 949,543	+25.8
Total	40,779,564	26,033,518	39,315,065	41,708,810	35,551,489	−6,157,321	−14.8

[a] Colorado includes Utah.
[b] Included with other States having less than three producers.
[c] Included with Colorado.

In the table following is given a statement of the establishments, the number of ovens built and building, the quantity of coal used, the quantity of coke produced, the value of the coke, the average price per ton, and the percentage yield of coal in coke for the years 1880, 1890, 1900, and from 1901 to 1911, inclusive.

Statistics of the manufacture of coke in the United States in 1880, 1890, and 1900–1911.

Year.	Establishments.	Ovens.		Coal used (short tons).	Coke produced (short tons).	Total value of coke at ovens.	Price of coke at ovens, per ton.	Percentage yield of coal in coke.
		Built.	Building.					
1880	186	12,372	1,159	5,237,741	3,338,300	$6,631,267	$1.99	63.0
1890	253	37,158	1,547	18,005,209	11,508,021	23,215,302	2.02	64.0
1900	396	58,484	5,804	32,113,553	20,533,348	47,443,331	2.31	63.9
1901	423	63,951	5,205	34,207,965	21,795,883	44,445,923	2.04	63.7
1902	456	69,069	8,758	39,604,007	25,401,730	63,339,167	2.49	64.1
1903	500	79,334	6,175	39,423,525	25,274,281	66,498,664	2.63	64.1
1904	507	83,599	4,430	36,531,608	23,661,106	46,144,941	1.95	64.8
1905	519	87,564	4,751	49,530,677	32,231,129	72,476,196	2.25	65.1
1906	532	93,901	4,519	55,746,374	36,401,217	91,608,034	2.52	65.3
1907	552	99,680	2.546	61,946,109	40,779,564	111,539,126	2.74	65.8
1908	551	101,218	2,241	39,440,837	26,033,518	62,483,983	2.40	66.0
1909	579	103,982	2,950	59,354,937	39,315,065	89,965,483	2.29	66.2
1910	578	104,440	2,567	63,088,327	41,708,810	99,742,701	2.39	66.1
1911	570	103,879	2,254	53,278,248	35,551,489	84,130,849	2.37	66.7

VALUE OF COKE PRODUCED.

The total value of the coke produced in 1911 was $84,130,849, a decrease as compared with 1910 of $15,611,852, or 15.6 per cent. The decrease in value would appear even larger than this except for the fact that the production of retort or by-product coke increased over 700,000 tons, and for reasons already explained retort coke brings a higher price at the ovens than beehive coke. The value of by-product coke increased from $24,793,016 to $27,297,897, a gain of $2,504,881, or 10.1 per cent, whereas the value of beehive or oven coke decreased from $74,949,655 to $56,832,952, a loss of $18,116,703, or 24.2 per cent. In the following tables are presented statements showing the value of coke produced in the several States for the last five years, with the amount and percentage of increase in 1911 as compared with 1910, and the total value of the coke produced in the United States in each year since 1880:

Total value, at the ovens, of the coke made in the United States, 1907–1911, by States, with increase and decrease in 1911.

State.	1907	1908	1909	1910	1911	Increase (+) or decrease (−) in value of coke produced.	
						1910–11	Per cent.
Alabama	$9.216,194	$7.169.901	$8,068,267	$9,165,821	$7,593,594	−$1,572,227	−17.2
Colorado [a]	4,747,436	3,238,888	4,135,931	4,273,579	3,880,710	− 392,869	− 9.2
Georgia	315,371	137,524	159,334	173,049	135,190	− 37,859	−21.9
Illinois	1,737.464	1,538,952	5,361,510	(b)	(b)	(b)	(b)
Kansas	19,837	8,011	....	(b)	(b)	(b)	(b)
Kentucky	(b)	(b)	101,257	120,554	134,862	+ 14,308	+11.9
Montana	(b)	(b)	(b)	(b)	....	....	....
New Mexico	840,253	826,780	1,099.694	1,306,136	1,240,963	− 65,173	− 5.0
New York	(b)	(b)	(b)	2,635,873	2,883,990	+ 248,117	+ 9.4
Ohio	819,262	491,982	683,155	911,987	961,904	+ 49,917	+ 5.5
Oklahoma (Indian Territory)	(b)	(b)	....	(b)	....		....
Pennsylvania	67,638,024	32,569,621	50,377.035	55,254,599	43,053,367	−12,201,232	−22.1
Tennessee	1,592,225	561,789	667,723	959,104	797,758	− 161,346	−16.8
Utah	(c)	(c)	(c)	(c)	(c)	(c)	(c)
Virginia	3,765,733	2,121,980	2,415,769	2,731,348	1,615,609	− 1,115,739	−40.8
Washington	293,019	213,138	240,604	347,540	216,262	− 131,278	−37.8
West Virginia	9,717,130	5,267,054	7,525,922	7,354,039	4,236,845	− 3,117,194	−42.4
Other States	10,837,178	8,338,363	9,129,282	7,796,522	17,379,795	+ 2,870,723	+19.8
Total	111,539,126	62,483,983	89,965,483	99,742,701	84,130,849	−15,611,852	−15.6

[a] Includes value of Utah coke.

[b] Included in other States having less than three producers.

[c] Included with Colorado.

Total value, at the ovens, of the coke made in the United States, 1880–1911.

1880	$6,631,265	1891	$20,393,216	1902	$63,339,167
1881	7,725,175	1892	23,536,141	1903	66,498,664
1882	8,462,167	1893	16,523,714	1904	46,144,941
1883	8,121,607	1894	12,328,856	1905	72,476,196
1884	7,242,878	1895	19,234,319	1906	91,608,034
1885	7,629,118	1896	21,660,729	1907	111,539,126
1886	11,153,366	1897	22,102,514	1908	62,483,983
1887	15,321,116	1898	25,586,699	1909	89,965,483
1888	12,445,963	1899	34,670,417	1910	99,742,701
1889	16,630,301	1900	47,443,331	1911	84,130,849
1890	23,215,302	1901	44,445,923		

From the preceding statements, which show the quantity and value of the coke produced in a series of years, the following tables have been prepared. These show the average price per ton obtained for the coke product in each State and Territory for the last five years and the average price of the total product since 1880. These average prices are obtained by dividing the total value by the total quantity of coke produced or sold. Although the figures may be accepted as indicating the general tendency of prices, they do not always represent the actual selling value of the coke, as has already been explained. Some of the largest producers of coke consume their entire product in their own blast furnaces. By some such producers the value of the coke is given at the actual cost of production; by others it is based upon the cost of production, a percentage of profit on the coking operations being added; and by still others the values are based upon the marketed product of a similar quality of coke in the immediate vicinity. These conditions, however, continue without material change from year to year, so that the prices as given may be accepted as indicating the general condition of the market.

The average prices of coke, by States, from 1907 to 1911, inclusive, and for the United States from 1880 to 1911 are shown in the following tables:

Average price per short ton, at the ovens, of the coke made in the United States, 1907–1911, by States.

State.	1907	1908	1909	1910	1911
Alabama	$3.05	$3.04	$2.61	$2.82	$2.75
Colorado [a]	3.34	3.30	3.30	3.17	3.30
Georgia	4.21	3.72	3.44	3.95	3.60
Illinois	4.66	4.25	4.20	4.43	(b)
Kansas	3.16	3.21	....	(b)	(b)
Kentucky	2.35	(b)	2.18	2.24	2.04
Montana	7.25	(b)	(b)	(b)	(b)
New Mexico	3.17	3.01	2.94	3.25	3.25
New York	(b)	(b)	(b)	4.04	4.20
Ohio	3.03	3.08	3.07	3.23	3.09
Oklahoma (Indian Territory)	4.32	(b)	....	(b)	(b)
Pennsylvania	2.55	2.10	2.02	2.10	1.96
Tennessee	3.41	2.62	2.55	2.97	2.41
Utah	(c)	(c)	(c)	(c)	(c)
Virginia	2.44	1.83	1.79	1.83	1.77
Washington	5.63	5.48	5.60	5.86	5.38
West Virginia	2.36	2.00	1.99	1.93	1.85
Other States	4.07	3.65	3.64	3.53	3.75
Average	2.74	2.40	2.29	2.39	2.37

[a] Includes Utah.
[b] Included in other States having less than three producers.
[c] Included with Colorado.

Average price per short ton, at the ovens, of the coke made in the United States, 1880–1911.

1880	$1.99	1891	$1.97	1902	$2.49
1881	1.88	1892	1.96	1903	2.63
1882	1.77	1893	1.74	1904	1.95
1883	1.49	1894	1.34	1905	2.25
1884	1.49	1895	1.44	1906	2.52
1885	1.49	1896	1.84	1907	2.74
1886	1.63	1897	1.66	1908	2.40
1887	2.01	1898	1.59	1909	2.29
1888	1.46	1899	1.76	1910	2.39
1889	1.62	1900	2.31	1911	2.37
1890	2.02	1901	2.04		

NUMBER OF COKE WORKS AND OVENS IN THE UNITED STATES.

In compiling the statistics of coke manufacture each bank of ovens is considered as a separate establishment, although in many cases these different establishments form a part only of one property and are reported from a central office. Different plants controlled or operated by one company are considered as much separate establishments as are the individual banks of ovens owned and operated by one firm or corporation. The year 1911 was somewhat remarkable for the number of idle plants and ovens and for the number of plants and ovens dismantled or abandoned. There were 18 plants with a total of 973 ovens abandoned, in addition to which 1,291 ovens, portions of other plants, were torn down. One company in the Connellsville region substituted 501 rectangular ovens for the same number of beehive ovens. There were 10 new plants and 1,703 new ovens put in blast, so that there was a net decrease of 8 in the number of establishments and of 561 in the number of completed ovens. There were 570 establishments in existence at the close of 1911, against 578 in 1910. Of the 18 establishments abandoned, 1 was in Illinois, 2 in Kansas, 1 in Missouri, 10 in Pennsylvania, 1 in Tennessee, 1 in Washington, and 2 in West Virginia. The average number of ovens to the abandoned plants was 54. In addition to the demolition of the 18 complete plants, there were 1,291 ovens, portions of other plants, which were dismantled and abandoned in 1911. There were 179 establishments with a total of 15,983 ovens which were idle throughout the entire year, in addition to which 24,416 ovens, portions of other plants, were also idle throughout the year, the total number of idle ovens being 40,399, which was approximately 40 per cent of the total number of ovens in existence. The number of plants which were in operation for all or a portion of the year was 391 and the number of ovens in blast for all or a portion of the year was 63,480. The number of active ovens for each plant averaged 162 in 1911, against 201 in 1910. The 179 plants that were idle during 1911 averaged 89 ovens to the plant. The 391 active establishments in 1911 produced 35,551,489 short tons of coke, or an average of 90,925 tons for each plant. In 1910 there were 478 active establishments which produced 41,708,810 tons of coke, an average of 87,257 tons for each plant. The concentration of the coking industry into comparatively large units has progressed markedly in recent years, as indicated by the fact that in 1880 there were 186 establishments which produced a total of 3,338,300 tons, an average of 17,948 tons to an establishment; the average production of each establishment in 1911 was more than five times the average of 1880. In 1880 there were 12,372 ovens in existence, an average of 67 to the establishment; in 1911 the average number of ovens to the establishment, including idle as well as active ovens, was 182. If instead of the number of plants the number of operating firms and corporations were considered as the unit, the concentration would appear to have been even more pronounced. An essential feature, however, in the increase in the average production per establishment and per oven during recent years has been the output from the growing number of by-product plants. In 1911 there were 4,320 active retort ovens in operation, with an average of 1,817 tons of production per oven. The large number of idle ovens in 1911 increased the average tonnage from the beehive plants from 376 tons per oven in 1910 to 468 in 1911. The total number of establishments manufacturing coke in the United States at the end of each decade from 1850 to 1900, and at the end of each year from 1901 to 1911, inclusive, is shown in the following table. The numbers reported in 1850, 1860, and 1870 are for the census years; the others are for calendar years.

Number of coke establishments in the United States since 1850.

1850 (census year)....	4	1901, December 31...	423	1907, December 31....	552
1860 (census year)....	21	1902, December 31...	456	1908, December 31....	551
1870 (census year)....	25	1903, December 31...	500	1909, December 31....	579
1880, December 31...	186	1904, December 31..	506	1910, December 31....	578
1890, December 31...	253	1905, December 31...	519	1911, December 31....	570
1900, December 31...	396	1906, December 31...	532		

The following table shows the number of coke ovens in existence in each State on December 31 for each of the last five years and at the end of each five years since 1880. The total number of ovens in existence at the close of 1911—103,879—was 4.2 per cent more than in 1907.

Number of coke ovens in each State at close of each year, 1907–1911.

State.	1907	1908	1909	1910	1911
Alabama	9,889	10,103	10,061	10,132	10,121
Colorado	3,799	3,841	3,846	3,611	3,606
Georgia	350	350	350	350	225
Illinois	309	430	468	508	506
Indiana	28	46	96	90	586
Kansas	83	67	67	71	53
Kentucky	495	495	494	495	577
Maryland	200	200	200	200	200
Massachusetts	400	400	400	400	400
Michigan	150	150	162	162	162
Minnesota	50	50	50	50	50
Missouri	5	4	4	4	....
Montana	567	551	551	451	451
New Jersey	150	150	150	150	150
New Mexico	896	1,016	1,030	1,030	1,030
New York	540	540	556	556	556
Ohio	600	481	447	496	496
Oklahoma (Indian Territory)	490	486	536	408	410
Pennsylvania	51,364	52,606	54,506	55,656	54,904
Tennessee	2,806	2,792	2,729	2,792	2,547
Utah	884	864	854	854	854
Virginia	5,333	4,853	5,469	5,389	5,496
Washington	216	231	285	285	235
West Virginia	19,688	20,124	20,283	19,912	19,876
Wisconsin	388	388	388	388	388
Total	99,680	101,218	103,982	104,440	103,879

The following table shows in a succinct statement the number of idle establishments and ovens, the number of establishments and ovens abandoned in 1911, and the number of establishments and ovens in the course of construction at the end of the year:

Number of coke establishments idle, abandoned, and in course of construction at the end of 1911.

State.	Idle.		Total number of ovens idle.	Abandoned.		Total number of ovens abandoned.	Building.		Total number of ovens building.
	Establishments.	Ovens.		Establishments.	Ovens.		Establishments.	Ovens.	
Alabama	14	2,474	2,804	0	0	0	1	280	280
Colorado	7	814	1,577	0	0	5	0	0	0
Georgia	1	50	50	0	0	125	0	0	0
Illinois	2	26	26	1	2	2	2	48	48
Indiana	2	46	46	0	0	0	1	22	92
Kansas	2	52	52	2	14	14	0	0	0
Kentucky	3	254	254	0	0	0	1	300	300
Massachusetts	0	0	23	0	0	0	0	0	0
Missouri	0	0	0	1	4	4	0	0	0
Montana	4	451	451	0	0	0	0	0	3
New Mexico	1	50	50	0	0	0	0	0	0
Ohio	2	75	139	0	0	0	0	0	0
Oklahoma	4	410	410	0	0	0	0	0	0
Pennsylvania	66	4,816	17,277	10	628	1,520	3	467	1,271
Tennessee	8	1,196	1,565	1	175	259	0	0	30
Utah	1	204	374	0	0	0	0	0	0
Virginia	4	656	3,223	0	0	0	0	0	100
Washington	3	75	134	1	50	50	0	0	0
West Virginia	55	4,334	11,764	2	100	285	0	0	130
Wisconsin	0	0	180	0	0	0	0	0	0
Total	179	15,983	40,399	18	973	2,264	8	1,117	2,254

Number of coke ovens in the United States on December 31 of each fifth year, from 1880 to 1911.

1880	12,372	1900	58,484
1885	20,116	1905	87,564
1890	37,158	1910	104,440
1895	45,565	1911	103,879

A statement of the number of ovens in course of construction at the end of each year since 1906 is shown in the following table. It is not intended by this to show the increase in the number of new ovens from year to year, nor does it include the number of new ovens completed during any one year. It merely exhibits the condition of the industry as shown by plants under construction at the close of each year.

Number of coke ovens building in the United States at the close of each year, 1906–1911.

1906	4,519	1909	2,950
1907	2,546	1910	2,567
1908	2,241	1911	2,254

RANK OF COKE-PRODUCING STATES.

Several important changes in the rank of the coke-producing States occurred as the result of the records made in 1911. Alabama again took second place, displacing West Virginia, which had held it for six successive years. In years of depression in the iron trade Alabama always shows a relative gain, owing to her advantages in local resources of iron ore, limestone, and coking coal, and her ability to make cheap iron. Consequently, in 1911 the decrease in the manufacture of coke in Alabama was relatively small. West Virginia, on the other hand, is at the disadvantage of having no local market for coke and her product must be disposed of in distant markets and in competition with other cokes. West Virginia's production in 1911 was more than 1,500,000 tons less than in 1910, whereas Alabama's production fell off only a little more than half that quantity and the output of the latter State exceeded that of the former by 130,000 tons. It should be stated, however, that large quantities of West Virginia coal are sent to other States, particularly to the retort-oven plants at Chicago and Joliet, Ill., and (in 1911) at Gary, Ind. The beehive-oven plants at Low Moor and Covington, Va., are also fired with West Virginia coal. If the coke from these establishments were credited to West Virginia, that State would be firmly fixed in second place. Virginia and Colorado are in much the same positions, relatively, as West Virginia and Alabama, and in 1911 for the same reasons that Alabama superseded West Virginia, Colorado displaced Virginia. The advance of Indiana from seventeenth to sixth place among the coke-producing States was the most important change of the year. It was due to the completion and putting in blast of 490 of the 560 Koppers by-product ovens by the United States Steel Corporation at Gary. This change was predicted in the report for 1910. Pennsylvania, of course, still holds, and for many years will continue to hold, first place, and Illinois continues fourth in rank. By the advances of Colorado and Indiana, Virginia dropped from fifth to seventh place. The next 10 States held the same positions in 1911 as in 1910. The positions held by the coke-producing States during the last five years are shown in the following table:

Rank of the States in production of coke, 1907–1911.

State.	1907	1908	1909	1910	1911
Pennsylvania	1	1	1	1	1
Alabama	3	3	3	3	2
West Virginia	2	2	2	2	3
Illinois	10	9	5	4	4
Colorado	5	5	6	6	5
Indiana	....	24	22	17	6
Virginia	4	4	4	5	7
New York	6	6	7	7	8
Wisconsin	7	8	8	8	9
Massachusetts	9	7	9	9	10
New Mexico	15	10	10	10	11
Michigan	13	13	11	11	12
Maryland	11	11	12	12	13
Tennessee	8	14	13	13	14
Ohio	14	15	15	14	15
New Jersey	16	12	14	15	16
Utah	12	16	16	16	17
Minnesota	17	17	17	18	18
Kentucky	19	20	19	20	19
Washington	20	19	20	19	20
Georgia	18	18	18	21	21
Kansas	23	23	....	24	22
Montana	21	21	21	22	....
Oklahoma	22	22	....	23	....

COAL CONSUMED IN THE MANUFACTURE OF COKE.

As stated in previous reports of this series, the determination of the quantity of coal consumed in the manufacture of coke is, to a considerable extent, a matter of estimate, a considerable quantity of the coal so used being charged directly into the ovens from the mines without having been previously weighed or measured. The only method of ascertaining the quantity of coal thus used is by the amount paid to the miners for mining, which is based sometimes on the measured bushel or ton and sometimes on the cubical contents of the mine car. All these standards are likely to differ materially from that of the weighed ton or bushel. There are comparatively few establishments in this country at which the quantity of coal made into coke is accurately ascertained, though as the industry becomes better organized greater attention is paid to exactness in this regard, and year by year the quantities as presented in the following tables become more accurate. It is still necessary, however, to estimate a large quantity of the coal consumed in the manufacture of coke.

A considerable quantity of the coal which is not run directly from the mines to the coke ovens is crushed and washed before coking. At some of the establishments the weight of this coal before washing is given approximately; at others the weight, after the slate, pyrite, and other impurities have been removed, is reported for the weight of the coal charged into the ovens; at still others coke ovens have been constructed chiefly for the purpose of utilizing the slack coal produced, in which case little or no account is taken of the weight of the coal. It can readily be seen, therefore, that any statement as to the quantity of coal used in the manufacture of coke is necessarily approximate; but as these differences appear from year to year the statistics as collected may be accepted as sufficiently accurate for comparative analysis. As previously stated, an apparent discrepancy appears between the statements regarding the quantities of coal consumed in the manufacture of coke as published in the chapter on coal production and those presented herewith. These discrepancies are, in general, due to the fact that a large quantity of coal is shipped to ovens at a distance from the mine. Where this is the case, the tonnage so shipped would be included in the shipments, the coal statistics showing only the quantity of coal made into coke at the mines.

The total quantity of coal made into coke in 1911 was 53,278,248 short tons, against 63,088,327 so used in 1910, a decrease of 9,810,079 tons, or 15.5 per cent.

The quantity of coal used in the manufacture of coke, as obtained for this report from the several States, from 1907 to 1911, and the quantity used during each fifth year since 1880 are shown in the following tables:

Quantity of coal used in the manufacture of coke in the United States, 1907–1911, by States, in short tons.

State.	1907	1908	1909	1910	1911
Alabama	4,973,296	3,875,791	5,080,764	5,272,322	4,411,298
Colorado [a]	2,388,911	1,546,044	1,984,985	2,069,266	1,810,335
Georgia	136,031	71,452	86,290	80,019	72,677
Illinois	514,983	503,359	1,682,122	1,972,955	(b)
Kansas	11,392	3,790	0	(b)	(b)
Kentucky	129,538	(b)	89,083	104,103	118,255
Montana	68,948	(b)	(b)	(b)	0
New Mexico	446,140	454,873	694,390	651,494	620,639
New York	(b)	(b)	(b)	910,293	955,067
Ohio	376,759	237,448	340,735	413,059	456,222
Oklahoma (Indian Territory)	38,615	(b)	0	(b)	0
Pennsylvania	39,733,177	23,215,964	36,983,568	39,455,785	32,875,655
Tennessee	825,221	395,936	493,283	597,658	628,118
Utah	(c)	(c)	(c)	(c)	(c)
Virginia	2,264,720	1,785,281	2,060,518	2,310,742	1,425,303
Washington	85,860	68,069	69,708	94,223	60,201
West Virginia	6,536,795	4,127,730	6,361,759	6,226,234	3,754,561
Other States	3,415,723	3,155,100	3,427,732	2,930,174	6,089,917
Total	61,946,109	39,440,837	59,354,937	63,088,327	53,278,248

[a] Includes coal coked in Utah.

[b] Included in other States having less than three producers.

[c] Included with Colorado.

Quantity of coal used in the manufacture of coke in the United States each fifth year, 1880–1911.

	Short tons.		Short tons.
1880	5,237,741	1900	32,113,543
1885	8,071,126	1905	49,530,677
1890	18,005,209	1910	63,088,327
1895	20,848,323	1911	53,278,248

QUANTITY AND VALUE OF COAL USED IN MAKING COKE.

The quantity of coal consumed in the manufacture of coke in 1911 was 53,278,248 short tons, a decrease of 9,810,079 short tons, or 15.5 per cent, as compared with 1910, when the quantity of coal consumed was 63,088,327 tons. The value of the coal consumed decreased $10,734,309, or 14.3 per cent, from $74,846,393 in 1910 to $64,112,084 in 1911. The average value per ton of the coal used in 1911 was $1.20, against $1.19 in 1910. The values of the coal used and of the coke produced show therefore a greater difference in 1911 than in 1910, for the average price per ton of coke, which was almost exactly double that of the coal used, declined from $2.39 to $2.37. There was, however, as shown in the succeeding paragraphs, a notable decrease in the quantity of coal required to make a ton of coke and a coordinate increase in the yield of coal in coke, due to nothing else than the increased output of by-product coke.

The total quantity and value of the coal consumed in the manufacture of coke in 1910 and 1911, with the quantity and value of the coal consumed per ton of coke produced, by States, are shown in the following table:

Quantity and value of coal used in the manufacture of coke in the United States in 1910 and 1911, and quantity and value of same per ton of coke, by States.

1910.

State.	Coal used (short tons).	Total value of coal.	Value of coal per ton.	Quantity of coal per ton of coke (short tons).	Value of coal to a ton of coke.
Alabama	5,272.322	$7,293.661	$1.38	1.623	$2.240
Colorado [a]	2,069,266	2,573,729	1.24	1.537	1.906
Georgia	80,019	103,605	1.29	1.826	2.356
Illinois	1,972,955	5,257,838	2.66	1.303	3.466
Kentucky	104,103	45,259	.43	1.933	.832
New Mexico	651,494	952,252	1.46	1.622	2.368
New York	910,293	2,150,571	2.36	1.315	3.292
Ohio	413,059	784,713	1.90	1.463	2.780
Pennsylvania	39,455,785	40,667.042	1.03	1.499	1.544
Tennessee	597.658	740,598	1.24	1.852	2.296
Virginia	2,310,742	2,029,751	.88	1.547	1.361
Washington	94,223	249,680	2.65	1.588	4.208
West Virginia	6,226.234	5,097,073	.82	1.637	1.342
Other States [b]	2,930,174	2,169,772	2.35	1.350	3.173
Total	63,088,327	74,846,393	1.19	1.513	1.800

[a] Includes Utah.

[b] Includes Indiana, Kansas, Maryland, Massachusetts, Michigan, Minnesota, Montana, New Jersey, New York, Oklahoma, and Wisconsin.

Quantity and value of coal used in the manufacture of coke in the United States in 1910 and 1911, and quantity and value of same per ton of coke, by States—Contd.

1911.

State.	Coal used (short tons).	Total value of coal.	Value of coal per ton.	Quantity of coal per ton of coke (short tons).	Value of coal to a ton of coke.
Alabama	4,411,298	$5,640,509	$1.28	1.597	$2.044
Colorado [a]	1,810,335	2,192,882	1.21	1.538	1.861
Georgia	72,677	113,403	1.55	1.935	2.999
Kentucky	118,255	61,658	.52	1.789	.930
New Mexico	620,639	960,481	1.55	1.625	2.519
New York	955,067	2,258,551	2.37	1.392	3.299
Ohio	456,222	853,655	1.87	1.465	2.740
Pennsylvania	32,875,655	32,923,460	1.00	1.500	1.500
Tennessee	628,118	636,058	1.01	1.901	1.920
Virginia	1,425,303	1,132,374	.79	1.566	1.237
Washington	60,201	127,959	2.13	1.498	3.191
West Virginia	3,754,561	3,037,531	.81	1.639	1,328
Other States [b]	6,089,917	14,173,563	2.33	1.314	3.062
Total	53,278,248	64,112,084	1.20	1.499	1.803

[a] Includes Utah.

[b] Includes Illinois, Indiana, Kansas, Maryland, Massachusetts, Michigan, Minnesota, New Jersey, and Wisconsin.

The following table shows approximately the quantity of coal, given in tons and pounds, required to produce a ton of coke in 1880, 1890, 1900, and annually since 1901. It will be noted that up to 1903 the quantity of coal required to produce a short ton of coke was from 3,120 to 3,140 pounds, or 1.56 to 1.57 tons. Since 1903, except in 1910, there has been a steady decrease in the quantity of coal required, the lowest figure, 2,998 pounds, being attained in 1911.

Coal required to produce a ton of coke, in tons and pounds.

Year.	Tons.	Pounds.	Year.	Tons.	Pounds.
1880	1.57	3,140	1905	1.537	3,074
1890	1.56	3,120	1906	1.531	3,062
1900	1.57	3,140	1907	1.519	3,038
1901	1.57	3,140	1908	1.515	3,030
1902	1.56	3,120	1909	1.510	3,020
1903	1.56	3,120	1910	1.513	3,026
1904	1.544	3,088	1911	1.499	2,998

YIELD OF COAL IN COKE.

As stated in the preceding paragraph, the increased production, both relative and actual, of coke in by-product ovens in 1911 resulted in a notable decrease in the quantity of coal required to make a ton of coke. Inferentially the yield of coal in coke was proportionately increased. The percentage of retort-oven coke to the total product increased from 17.12 per cent in 1910 to 22.07 per cent in 1911, and the yield of coal in coke increased from 66.1 per cent to 66.7 per cent. In 1880, before any retort-oven coke was made in the United States, the percentage yield of coal in coke was reported to have been 63. Even this figure is believed to have been higher than the results actually obtained, for at that time "rule of thumb" methods were generally practiced, little if any idea of the quantity of coal charged was accurately ascertained, and in making estimates on the subject operators were inclined to understate the quantity of coal used. It is doubtful if the actual yield of coal in coke exceeded 60 per cent. In consonance with improved and more exact methods in all branches of modern industry, particularly manufacturing, coke manufacturers are keeping more accurate records of the results accomplished in both by-product and nonrecovery oven practice, and from year to year the statements of yield become more reliable. The figures for the last few years are believed to be very close to actual results.

The influence on the yield by the operations of the by-product ovens is clearly shown in the following table. It will be observed that in Illinois, Indiana, Massachusetts, Michigan, New Jersey, New York, and Wisconsin, in which States the coke product is exclusively from retort ovens, the yield varies from 71.8 per cent to 80.6 per cent, whereas in the States where beehive practice prevails the yield varies from 51.7 to 69.3 per cent. The average yield from all retort ovens in 1911 was 75.1 per cent, while that from nonrecovery ovens was 64.7 per cent.

The following tables show the percentage yield of coal in coke in each State during the last five years and for the United States in each tenth year since 1880 and annually since 1901:

Percentage yield of coal in coke, 1907–1911, by States.

State.	1907	1908	1909	1910	1911
Alahama	61.0	61.0	60.7	61.6	62.6
Colorado[a]	59.5	63.5	63.1	65.1	65.0
Georgia	55.1	55.2	53.8	54.8	51.7
Illinois	72.3	72.0	75.9	76.8	77.1
Indiana	....	70.0	44.4	78.3	80.6
Kansas	55.0	65.9	....	75.2	70.0
Kentucky	51.7	50.0	52.0	51.7	55.9
Montana	59.0	58.3	44.7	44.7	....
New Mexico	59.4	60.4	53.9	61.6	61.5
Ohio	71.8	67.2	65.4	68.3	68.2
Oklahoma (Indian Territory)	49.4	46.0	....	45.0	....
Pennsylvania	66.7	66.8	67.3	66.7	66.7
Tennessee	56.6	54.2	53.1	54.0	52.6
Virginia	68.2	65.1	65.4	64.6	63.9
Washington	60.6	57.1	61.7	63.0	66.6
West Virginia	62.9	63.9	62.0	61.1	60.4
Maryland	73.0	72.1	67.9	65.6	66.2
Massachusetts	75.0	76.4	77.7	77.3	77.4
Michigan	77.0	74.5	74.1	75.7	74.2
Minnesota	68.0	66.4	67.7	68.0	67.6
New Jersey	80.0	72.3	77.7	76.1	76.2
New York	72.0	71.3	72.0	71.7	71.8
Wisconsin	74.0	74.5	76.1	77.4	74.9
Wyoming	....	....	....	....	....
Total average	65.8	66.0	66.2	66.1	66.7

[a] Includes Utah.

Percentage yield of coal in coke, 1880–1910.

1880	63.0	1903	64.1	1908	66.0
1890	64.0	1904	64.8	1909	66.2
1900	63.9	1905	65.1	1910	66.1
1901	63.7	1906	65.3	1911	66.7
1902	64.1	1907	65.8		

CONDITION IN WHICH COAL IS CHARGED INTO THE OVENS.

In the following table is to be found a statement of the condition in which the coal is charged into the ovens in the several States for the last two years and for each of the five-year periods since 1890. In a number of the coking districts the principal oven fuel is the slack coal produced in the mining operations. By far the larger quantity, however, is run of mine, some of which is crushed before being charged into the ovens, as in many cases it is found that a better and more uniform quality of coke is obtained when the coal is crushed before coking. Considerable quantities of both mine-run and slack coal are washed before being coked in order to remove the impurities consisting of slate, pyrite, etc. In 1911 21.5 per cent of all the coal charged into the coke ovens was washed and 78.5 per cent was used without other preparation than, in some instances, crushing. The mine-run coal that is crushed before coking is considered as mine-run coal and not as slack.

In Pennsylvania and West Virginia and in the by-product coke-producing States that draw their coal supplies chiefly from Pennsylvania and West Virginia the larger part of the coal used is unwashed. In West Virginia most of the coal used in making coke is unwashed slack, as a majority of the ovens in that State were constructed for the purpose of utilizing the slack. In Pennsylvania and the other States in which unwashed coal is used the greater part of it is run of mine. In Alabama most of the coal used is washed, and nearly two-thirds of the total coal used in the State is washed slack. All of the coal used in Georgia, New Mexico, and Tennessee is washed, and in the first two it is slack exclusively. In Colorado the larger part of the coal used is washed run of mine, and in Virginia the quantity of coal is nearly evenly divided between run of mine and slack, all of it being unwashed.

In 1911 the total quantity of coal used for coke making was 53,278,248 short tons, of which 41,281,395 tons (36,362,875 tons unwashed and 4,918,520 tons washed) were run of mine, and 11,996,853 tons (5,460,689 tons unwashed and 6,536,164 tons washed) were slack.

The table following shows the quantity of run-of-mine and of slack coal, unwashed and washed, charged into the ovens in 1910 and 1911, by States, with the percentage of each.

Character of coal used in the manufacture of coke, by States, in 1910 and 1911, in short tons.

State	Run-of-mine.		Slack.		Total.			
	Unwashed.	Washed.	Unwashed.	Washed.	Unwashed.	Percentage.	Washed.	Percentage
1910.								
Alabama	771,931	1,308,085	0	3,192,306	771,931	14.6	4,500,391	85.4
Colorado[a]	252,468	836,067	429,728	551,003	682,196	33.0	1,387,070	67.0
Georgia	1,811	0	0	78,208	1,811	2.3	78,208	97.7
Illinois	1,971,386	0	0	1,569	1,971,386	99.9	1,569	0.1
Kentucky	17,695	0	620	85,788	18,315	17.6	85,788	82.4
New Mexico	0	0	0	651,494	0	....	651,494	100.0
Ohio	333,397	0	12,212	67,450	345,609	83.7	67,450	16.3
Pennsylvania	32,688,029	2,372,115	1,275,348	3,120,293	33,963,377	86.1	5,492,408	13.9
Tennessee	41,650	346,769	0	209,239	41,650	7.0	556,008	93.0
Virginia	1,554,784	0	755,958	0	2,310,742	100.0	0	....
Washington	0	3,361	0	90,862	0	....	94,223	100.0
West Virginia	2,088,553	234,484	3,462,927	440,270	5,551,480	89.2	674,754	10.8
Indiana Kansas Maryland Massachusetts Michigan Minnesota Montana New Jersey New York Oklahoma Wisconsin	2,832,620	78,034	905,285	24,528	3,737,905	97.3	102,562	2.7
Total	42,554,324	5,178,915	6,842,078	8,513,010	49,396,402	78.3	13,691,925	21.7
1911.								
Alabama	693,135	1,295,109	2,937	2,420,117	696,072	15.8	3,715,226	84.2
Colorado[a]	0	1,025,031	428,971	356,333	428,971	23.7	1,381,364	76.3
Georgia	0	0	0	72,677	0	....	72,677	100.0
Kentucky	33,353	0	10,908	73,994	44,261	37.4	73,994	62.6
New Mexico	0	0	0	620,639	0	....	620,639	100.0
New York	760,114	128,550	25,594	40,809	785,708	82.3	169,359	17.7
Ohio	417,101	16,574	5,504	17,043	422,605	92.6	33,617	7.4
Pennsylvania	27,601,050	1,958,360	1,029,149	2,287,096	28,630,199	87.1	4,245,456	12.9
Tennessee	....	283,203	0	344,915	0	....	628,118	100.0
Virginia	675,497	0	749,806	0	1,425,303	100.0	0	....
Washington	0	20,154	0	40,047	0	....	60,201	100.0
West Virginia	925,460	158,308	2,408,299	262,494	3,333,759	88.8	420,802	11.2
Illinois Indiana Kansas Maryland Massachusetts Michigan Minnesota Montana New Jersey Oklahoma Wisconsin	5,257,165	33,231	799,521	0	6,056,686	99.5	33,231	.5
Total	36,362,875	4,918,520	5,460,689	6,536,164	41,823,564	78.5	11,454,684	21.5

[a] Includes Utah.

In the following table are given the statistics of the character of the coal used in coke making each fifth year since 1890, including 1911:

Character of coal used in the manufacture of coke in the United States, 1890-1911, in short tons.

Year.	Run-of-mine.		Slack.		Total.
	Unwashed.	Washed.	Unwashed.	Washed.	
1890	14,060,907	338,563	2,674,492	931,247	18,005,209
1895	15,609,875	237,468	3,052,246	1,948,734	20,848,323
1900	21,062,090	1,369,698	5,677,006	4,004,749	32,113,543
1905	31,783,314	3,187,994	8,196,226	6,363,143	49,530,677
1910	42,554,324	5,178,915	6,842,078	8,513,010	63,088,327
1911	36,362,875	4,918,520	5,460,689	6,536,164	53,278.248

COKE MAKING IN BY-PRODUCT OVENS.

The most prominent feature connected with the coke-making industry in 1911 was the increase in the production of by-product coke, whereas the total production exhibited a marked decline. The record of 1911 bears out the statements made in preceding reports of this series that beehive and other types of ovens, in which the process is one of partial combustion, must in the order of progress give way to the more modern types represented by retort or by-product recovery ovens, in which the process is one of distillation. In the partial combustion process as conducted in the beehive and similar types of ovens not only are all of the other constituents of the coal, except the fixed carbon and the heat generated in the process, wasted, but the yield of coke itself is materially reduced because of the impossibility of preventing the combustion of a part of the fixed carbon. With some of the high-carbon, low-volatile coals like the Pocahontas and the better grades of New River (West Virginia) coals it is necessary to burn some of the fixed carbon in order to get a sufficient heat to produce the desired quality of coke. In the distillation process as employed in the retort or by-product recovery ovens, the constituents of the coal, wasted in the beehive ovens, are recovered and utilized. Some retort ovens remote from consuming centers where the surplus gas, the tar, and the ammonia can not be disposed of, are operated as "waste heat" ovens without recovery apparatus, the "waste heat," so called, being in reality not wasted but utilized in the boiler plant for the generation of power. Similarly a few plants of beehive ovens have been constructed with flues by which the burning gases are conveyed to the boiler plant and utilized. Both of these are exceptions, however, and not the rule.

The production of coke in retort ovens in 1911 amounted to 7,847,845 short tons, an increase as compared with 1910 of 709,111 tons, or nearly 10 per cent. This compares with a decrease of nearly 15 per cent in the total production and of 19.86 per cent in the production of beehive coke, including with "beehive" coke the output of rectangular, Welsh, and other nonrecovery ovens. The increase in the production of retort coke was due principally to the completion of a part of the United States Steel Corporation's plant at Gary, Ind. This plant is designed for 560 ovens, of which 490 were completed in

1911. The result of their operations in 1911, in addition to increasing the output of retort coke over 1910, advanced Indiana from seventeenth to sixth in the rank of coke-producing States. The production of retort-oven coke in 1911 was 22.07 per cent of the total; in 1910 it was 17.12 per cent; and in 1909 it was 15.91 per cent.

The number of by-product ovens in operation was increased by 546 in 1911 over 1910. The new ovens consisted of 490 Koppers ovens, completed by the United States Steel Corporation, at Gary, Ind., already referred to, and 60 of the same type constructed by the Woodward Iron Co., at Woodward, Ala., making a total of 550. Four Otto-Hoffman, at Lebanon, Pa., were dismantled, reducing the net increase over 1910 to 546. The new construction, incomplete at the end of 1911 consisted of 280 Koppers ovens for the Tennessee Coal, Iron & Railroad Co., at Corey, Ala., begun in 1910; 35 Koppers ovens for the Coal Products Manufacturing Co., at Joliet, Ill., begun in 1911; 13 Semet-Solvay ovens for the North Shore Gas Co., at Waukegan, Ill.; 70 Koppers ovens to complete plant for the United States Steel Corporation, at Gary, Ind.; and 300 Didier ovens for the Lehigh Coke Co., at South Bethlehem, Pa., begun in 1910.

Not all of the 4,624 completed retort ovens were operated in 1911. One plant of 25 ovens was idle the entire year and 279 ovens, parts of other plants, were out of blast, making the number of active ovens 4,320. The average production from these active ovens was 1,817 short tons of coke as compared with 1,762 tons per oven in 1910, 1,598 tons in 1909, and 1,142 tons in 1908. The average production for each active beehive oven in 1911 was 468 short tons, against 376 tons in 1910, 361 tons in 1909 and 258 tons in 1908. The average production from beehive ovens was unusually large in 1911, due to the exceptionally large number of ovens that were idle for the entire year. The average production of retort ovens is generally about five times that of the beehive; in 1911 it was about four times.

The average value of the yield from retort ovens, including the value of the by-products, in 1911, was $8,642 per oven, excluding, of course, the ovens that were idle throughout the entire year. The average value of the coke produced from each active beehive oven was $961, the yearly yield in value for each retort oven being nine times that obtained from beehive ovens. The quantity of coal consumed in the manufacture of coke and by-products in retorts in 1911 was 10,446,584 short tons, which yielded 7,847,845 tons of coke, an average yield of coal in coke of 75.1 per cent. In 1910 the average yield in the by-product ovens was 74.9 per cent and in 1909 it was 74.5 per cent. The average yield of coal in coke in the beehive ovens in 1911 was 64.7 per cent, the difference in favor of retort ovens being 10.4 points, or 16 per cent. The value of the 10,446,584 short tons of coal consumed in the retort ovens in 1911 was $24,056,906, an average of $2.30 per ton. The quantity of coal consumed in beehive ovens in 1911 was 42,831,664 short tons, valued at $40,055,178, or 94 cents per ton, the difference in this value being due to the fact that in beehive practice the ovens are in the vicinity of the mines from which the coal is delivered immediately to the larries, and no transportation expenses are added to the cost of the coal. The retort-oven plants are located at a distance from the mines and near the points of consumption, so that the transportation expenses are added to the value of the coal charged into the ovens.

The value of the 7,847,845 short tons of coke made in by-product ovens in 1911 was $27,297,897, an average per ton of $3.48. The quantity of coke produced in beehive ovens in 1911 was 27,703,644 short tons, valued at $56,832,952, or $2.05 per ton, the difference of $1.43 in favor of the value per ton of beehive coke at the ovens being more than offset by the cost of transportation from the ovens to the points of consumption.

The total value of the by-products obtained from the manufacture of coke in retort ovens in 1911 was $10,033,961, or a little more than one-third of the value of the coke produced. In 1910 the value of the by-products amounted to $8,479,557, and in 1909 the value of the by-products recovered was $8,073,948. The by-products recovered in 1911 consisted of 33,274,861 thousand feet of surplus gas, valued at $3,781,218; 69,410,559 gallons of tar, valued at $1,638,314; 72,920,056 pounds of ammonium sulphate or its equivalent, valued at $1,943,761; 23,180,118 pounds of anhydrous ammonia, valued at $1,847,929; and 4,660,596 gallons of ammonia liquor (the strength of which was not reported), valued at $548,824. The value of the recoverable contents of the coal made into coke in beehive ovens which are wasted would, at the prices obtaining in 1911, have been worth between thirty-five and forty millions of dollars.

The value of the by-products recovered in 1911 was equal to the value at the mines of the coal used.

The average production from the retort or by-product ovens in 1911 was 1,817 short tons; the total quantity of coke produced was 35,551,489 short tons. If all of the coke produced in 1911 had been made in retort ovens and the average production per oven in 1911 maintained, it appears that the total number of ovens required to produce this amount of coke would have been about 20,000. Further, if no attempt were made to recover the by-products from these ovens—that is to say, if they were operated as "waste-heat" ovens—they would be capable of yielding 20 horsepower per hour in a steam-boiler plant operated in connection with the ovens. The quantity of boiler horsepower obtainable, therefore, from this source would be about 400,000 horsepower per hour for every day of the year.

The production of coke in the Connellsville and Lower Connellsville districts of Pennsylvania in 1911 amounted to 16,919,749 short tons, to produce which in retort ovens would require about 9,300 such ovens. These operated as "waste-heat" ovens would produce approximately 180,000 boiler horsepower per hour.

Through the courtesy of the late R. N. Durborow, general superintendent of motive power of the Pennsylvania Railroad Co., the writer has received estimates of the quantity of drawbar horsepower developed by some of the locomotives of that company during 1910. Mr. Durborow stated that it required about 32,358 drawbar horsepower as the average during the month of March, 1911, to haul the freight trains over the portion of the Pennsylvania system between Pittsburgh and Harrisburg. For the passenger trains 9,762 drawbar horsepower is required, the total drawbar horsepower developed per day being 42,120. The efficiency of transmission from the power house to substations on the line would be about 82 per cent for the distance between Pittsburgh and Harrisburg, and 42,000 drawbar horsepower. The efficiency of the distributing system between the substations and the locomotives would be about 85 per cent, and the efficiency of the locomotive itself would be about 75 per cent. The power that would reach the drawbar of the locomotive and thus be available for a train would, therefore, be about 52.3 per cent, this being the product of 82 by 85 by 75 per cent. Assuming, therefore, that 42,000 drawbar horsepower is 52.3 per cent of the power-plant horsepower, sufficient to move the traffic, 80,000 horsepower would be required at the power house.

Mr. Durborow was kind enough to submit the following tables giving the estimates of the horsepower developed by the different classes of locomotives, by freight trains, and by passenger trains, during the month of March, 1911, from which the foregoing estimates have been deduced.

Estimate of the horsepower developed by different classes of locomotives making an average trip over the Pittsburgh and Middle divisions of the Pennsylvania Railroad.

Freight trains, month of March, 1911.

Number of trains per month.	Average running time (hours).	Locomotive class.	Average horsepower.	Total horsepower hours per month of 31 days.
Altoona and Harrisburg, eastbound:				
686, slow	10.80	H-8	650	4,815,720
439, preferred	8.85	H-6	600	2,331,090
Altoona and Harrisburg, westbound:				
608, slow	11.36	H-8	650	4,489,472
393, preferred	8.35	H-6	600	1,968,930
Altoona and Pittsburgh, west and east bound—all freight trains:				
1,851	8.76	H-6	600	9,728,856
130	8.76	H-8	650	740,220
Total trains 4,107				24,074,288

744 hours in 31 days; $\frac{24,074,288}{744}$ =32,358 horsepower required any instant.

Passenger trains, month of March, 1911.

Altoona and Harrisburg, east and west bound:				
1,777	3.03	E	450	2,423,828
533	3.03	K	660	1,066,000
Altoona and Pittsburgh, east and west bound:				
1,247	3.30	K	660	2,715,966
712	3.30	E	450	1,057,320
Total trains, 4,269				7,263,114

$\frac{7,263,114}{744}$ =9,762 horsepower required at any instant.

From the foregoing it appears that the quantity of power which might be obtained from the coking operations in the Connellsville and Lower Connellsville districts by substituting nonrecovery retort ovens for the beehive ovens would be more than twice the quantity of power necessary to move every train on the Pennsylvania Railroad between Pittsburgh and Harrisburg.

This estimate is of course roughly calculated, as the efficiency of a power plant will range from one-half horsepower per boiler horsepower in a small, simple noncondensing engine to three horsepower in the best compound condensing engines. The power used on the railroad is not uniform, the rate of fuel consumption varying during all hours of the day and from day to day. Moreover, the conversion of boiler horsepower per oven into dynamometer (drawbar) horsepower may differ considerably in practice, but allowing for all possible errors and variations the enormous waste of energy now obtaining in the coking districts of Pennsylvania is glaringly apparent.

The total value of the coke, gas, tar, ammonia, and other products produced at by-product recovery ovens during the last three years is shown in the table following:

Value of products obtained in manufacture of coke in retort ovens in 1909, 1910, and 1911.

	1909		1910		1911	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Gas..............M cubic feet..	15,791,220	$2,609,211	27,692,858	$3,017,908	33,274,861	$3,781,218
Tar..................gallons..	60,126,006	1,408,611	66,303,214	1,599,453	69,410,599	1,638,314
Ammonia, sulphate or reduced to equivalent in sulphate, pounds....................	123,111,197	3,227,316	70,247,543	1,841,062	72,920,056	1,943,761
Ammonia liquor......gallons..	....	....	4,654,282	295,868	[a] 4,660,596	[a] 548,824
Anhydrous ammonia.pounds..	4,871,014	448,455	20,229,421	1,725,266	23.180,118	1,847,929
All other products............	....	380,355	....	....	....	273,915
Total value of by-products	....	8,073,948	....	8,479,557	....	10,033,961
Coke..............short tons..	6,254,644	20,434,689	7,138,734	24,793,016	7,847,845	27,297,897
Grand total...............	....	28,508,637	....	33,272,573	....	37,331,858

[a] Includes a considerable quantity of 100 per cent NH_3 liquor and of liquor sold on NH_3 content, which accounts for apparent marked increase in value.

The gas included in the foregoing statement is the "surplus" not consumed in the coking process, which is either sold or used at manufacturing establishments operated in connection with the coke-oven plant. In some cases where the surplus gas is consumed by the producing or an affiliated company both the quantity and the value of the surplus gas become a matter of estimate, but the figures as presented are believed to be sufficiently accurate for statistical purposes. The value is usually placed at 10 to 15 cents per 1,000 cubic feet. The relatively lower value of the gas produced in 1910 and 1911 as compared with the preceding year is due largely to the operations of the Koppers ovens at Joliet, which yield a large quantity of surplus gas, and the gas is delivered to the United States Steel Corporation at a low valuation. The first plant of by-product ovens installed in the United States was a bank of 12 Semet-Solvay ovens at Syracuse, N. Y. In the first year of their operation these ovens produced 12,850 short tons of coke. This plant has since been increased to 40 ovens. The first plant of United-Otto (Otto-Hoffmann) ovens was one of 60 units, constructed at Johnstown, Pa., and operated in connection with the iron and steel works of the (now) Cambria Steel Co.; this plant has since been enlarged several times and now contains a total of 372 ovens. An experimental plant of Newton-Chambers ovens was built at Latrobe, Pa., about 12 years ago, but was never operated. These ovens were afterwards torn down and rebuilt at Pocahontas, Va., in 1900, but have not been in blast except for a short time immediately after completion. In 1906 a bank of this type of oven, 152 in number, was begun at Vintondale, Pa. The ovens were completed and put in blast in 1907, but as neither this plant nor the one at Pocahontas has ever been operated for by-product recovery, they have been taken from the list of by-product ovens. In 1904 the Lackawanna Steel Co. constructed a plant of 94 Rothberg ovens at Buffalo, N. Y.; this plant has since been enlarged to 282 ovens. The first establishment of Koppers regenerative ovens was begun in 1907 by the Illinois Steel Co., at Joliet, Ill.; it consists of 280 ovens, 140 of which were finished and put in blast in 1908, and the second installment was completed and put in blast in 1909. It is evident that this plant has yielded satisfactory results, for the United States Steel Corporation began in 1909 an additional plant of 560 Koppers ovens at its new town of Gary, Ind. Of these ovens 490 were completed and put in blast in 1911. Other work completed in 1911 consisted of 60 Koppers regenerative ovens built by the Woodward Iron Co., at Woodward, Ala. There were 50 United-Otto ovens completed and put in blast by the Citizens Gas Co., at Indianapolis, Ind., during 1910. The Didier-March Co., of New York, began in 1910 the construction of 300 Didier by-product ovens at South Bethlehem, Pa. These ovens when completed will be operated by the Lehigh Coke Co. In addition to the Didier ovens, the incomplete plants at the close of 1911 were, 280 Koppers ovens by the Tennessee Coal, Iron & Railroad Co., at Corey, Ala.; 13 Semet-Solvay ovens at Waukegan, Ill.; and 35 Koppers ovens at Joliet, Ill. Altogether, at the close of 1911 there were 4,624 by-product ovens in existence and 698 in course of construction. The development of the by-product recovery coking process in the United States since 1893 is shown in the following table:

Record of by-product ovens, by States, 1907–1911.

State.	Dec. 31, 1907.		Dec. 31, 1908.		Dec. 31, 1909.		Dec. 31, 1910.		Dec. 31, 1911.	
	Built.	Building.	Built.	Building.	Built.	Building.	Built.	Building.	Built.	Building.
Alabama	280	0	280	0	280	0	280	340	340	280
Illinois	160	280	300	140	440	40	480	0	480	48
Indiana	0	0	0	50	50	560	50	560	540	70
Maryland	200	0	200	0	200	0	200	0	200	0
Massachusetts	400	0	400	0	400	0	400	0	400	0
Michigan	150	0	150	0	162	0	162	0	162	0
Minnesota	50	0	50	0	50	0	50	0	50	0
New Jersey	150	0	150	0	150	0	150	0	150	0
New York	540	0	540	0	556	0	556	0	556	0
Ohio	155	50	155	50	125	49	174	0	174	0
Pennsylvania	1,319	0	1,294	0	1,296	[a] 300	1,296	300	1,292	300
West Virginia	120	0	120	0	120	0	120	0	120	0
Wisconsin	160	0	160	0	160	0	160	0	160	0
Total	3,684	330	3,799	240	3,989	949	4,078	1,200	4,624	698

[a] Contracted for; construction begun in 1910.

Record of by-product coke making, 1893–1911.

Year.	Ovens.		Production (short tons).	Year.	Ovens.		Production (short tons).
	Built.	Building.			Built.	Building.	
1893	12	0	12,850	1903	1,956	1,335	1,882,39
1894	12	60	16,500	1904	2,910	832	2,608,22
1895	72	60	18,521	1905	3,103	417	3,462,34
1896	160	120	83,038	1906	3,547	112	4,558,12
1897	280	240	261,912	1907	3,684	330	5,607,89
1898	520	500	294,445	1908	3,799	240	4,201,22
1899	1,020	65	906,534	1909	3,989	949	6,254,64
1900	1,085	1,096	1,075,727	1910	4,078	1,200	7,138,73
1901	1,165	1,533	1,179,900	1911	[a] 4,624	[b] 698	7,847,84
1902	1,663	1,346	1,403,588				

[a] Includes 1,387 Semet-Solvay, 2,100 United-Otto, 307 Rothberg, and 830 Koppers.
[b] Includes 350 Koppers, 13 Semet-Solvay, and 300 Didier ovens.

The increase in the production of retort-oven coke compared with that of beehive coke since 1893 is shown in the following table. In the last ten years, or from 1901 to 1911, the increase in beehive coke has amounted to 34.4 per cent, while that of retort-oven coke has amounted to 565 per cent. During the same period the value of the beehive product has increased 36.8 per cent and that of retort-oven coke has increased 843 per cent.

Production of by-product coke, compared with that of beehive coke, 1893–1911.

Year.	By-product coke.		Beehive coke.		Total.	
	Quantity (short tons).	Value.	Quantity. (short tons).	Value.	Quantity (short tons).	Value.
1893	12,850	....	9,464,730	....	9,477,580	$16,523,714
1901	1,179,900	$2,894,077	20,615,983	$41,551,846	21,795,883	44,445,923
1907	5,607,899	21,665,157	35,171,665	89,873,969	40,779,564	111,539,126
1908	4,201,226	14,465,429	21,832,292	48,018,554	26,033,518	62,483,983
1909	6,254,644	20,434,689	33,060,421	69,530,794	39,315,065	89,965,483
1910	7,138,734	24,793,016	34,570,076	74,949,685	41,708,810	99,742,701
1911	7,847,845	27,297,897	27,703,644	56,832,952	35,551,489	84,130,849

The distribution, by States and by kinds, of by-product ovens built and building in the United States at the close of 1911 is shown in the following table:

Kinds of by-product ovens built and building in the United States, by States, at the close of 1911.

State.	United-Otto.[a]	Semet-Solvay.	Roth-berg.	Koppers.	Total.	
	Built.	Built.	Built.	Built.	Built.	Building.
Alabama	0	280	0	60	340	[b] 280
Illinois	0	200	0	280	480	[c] 48
Indiana	50	0	0	490	540	[b] 70
Maryland	200	0	0	0	200	0
Massachusetts	400	0	0	0	400	0
Michigan	30	132	0	0	162	0
Minnesota	50	0	0	0	50	0
New Jersey	150	0	0	0	150	0
New York	188	86	282	0	556	0
Ohio	100	49	25	0	174	0
Pennsylvania	932	360	0	0	1,292	[d] 300
West Virginia	0	120	0	0	120	0
Wisconsin	0	160	0	0	160	0
Total	2,100	1,387	307	830	4,624	698

[a] Includes the Otto-Hoffmann and Schniewind types.
[b] Koppers ovens.
[c] 13 Semet-Solvay and 35 Koppers.
[d] Didier ovens.

The following table, originally compiled by Mr. Albert Ladd Colby, consulting engineer, South Bethlehem, Pa., was first published in the report for 1906. It has since been revised by Mr. C. G. Atwater, of the United Coke & Gas Co., Whitehall Building, New York City, and by Mr. W. H. Blauvelt, of the Semet-Solvay Co., Syracuse, N. Y.

This table shows, in addition to the number of ovens at each by-product coke-oven plant in the United States, the uses to which the coke and gas are put, the dates the plants were put in operation, and other interesting information regarding their construction and operation.

Complete list of by-product and retort coke-oven plants of the United States, January 1, 1912.

State.	Town.	System.	Name of company owning plant.	Number of installments.	Date put in operation.	Number of ovens.	Uses of coke.	Uses of surplus gas.	Remarks.
Ala.	Ensley (near Birmingham).	Semet-Solvay	Tennessee Coal, Iron & R. R. Co.	First	Oct., 1898	120	Blast furnace	Fuel gas	
				Second	Mar., 1902	120	do	do	
	Tuscaloosa	do	Central Iron & Coal Co.	First	Feb., 1906	40	do	do	
	Woodward	Koppers	Woodward Iron Co.	do	Began construction 1910.	60	do	Fuel and power	
	Corey	do	Tennessee Coal, Iron & R. R. Co.	do	do	280	do	do	
Ill.	Joliet	do	Coal Products Manufacturing Co.	do	Began construction 1911.	35			
	do	do	Illinois Steel Co.	do	Completed in 1908.	140	Blast furnace	Fuel and power	
	do	do	do	Second	Mar., 1909	140	do	do	
	South Chicago, on Calumet River.	Semet-Solvay	By-products Coke Corporation.	First	Dec., 1905	120	Blast furnace, foundry, and domestic.	Illuminating	
				Second	Dec., 1906	40			
				Third	1910	40			
	Waukegan	do	North Shore Gas Co.	First	Began construction 1911.	13			
Ind.	Gary	Koppers	Illinois Steel Co.	do	490 completed in 1911.	560	Blast furnace	Fuel	
	Indianapolis	United-Otto	Citizens Gas Co.	do	Completed 1909.	50	Blast furnace and foundry.	Fuel and illuminating gas for Indianapolis.	
Md.	Sparrows Point	do	Maryland Steel Co.	do	Mar., 1903	200	Blast furnace	Illuminating gas for city of Baltimore, 11 miles distant; 4,000,000 cubic feet daily.	
Mass.	Everett	Otto-Hoffmann	New England Gas & Coke Co.	do	June, 1899	400	Domestic, industrial, and locomotive in about equal proportion.	Illuminating gas and fuel gas; 6,500,000 to 7,500,000 cubic feet daily of illuminating gas.	First illuminating-gas system installed.
Mich.	Delray	Semet-Solvay	The Solvay Process Co.	do	Sept., 1901	30	Furnace, foundry, domestic, and lime burning.	Illuminating and fuel	
				Second	Nov., 1902	30			
				Third	Mar., 1906	60			
				Fourth	1909	12			
	Wyandotte	United-Otto	Michigan Alkali Co.	First	Oct., 1902	15	Burning limestone.	Fuel gas	Use the by-products in their works.
				Second	Aug., 1906	15			
Minn.	Duluth	do	Zenith Furnace Co.	First	July, 1904	50	Blast furnace	Illuminating gas for Duluth.	

N. J.	Camden	Otto-Hoffman	Camden Coke Co.	do	About Jan., 1903.	100	do	Illuminating gas and fuel gas 2,500,000 to 3,000,000 cubic feet. Illuminating gas pumped daily under 10 pounds pressure to Trenton, 38 miles distant. In 1906 extended delivery of illuminating gas to New Brunswick and Plainfield, 83 miles from Camden. Towns now included: Camden, Bordentown, Woodbury, Trenton, New Brunswick, Plainfield, and smaller towns.	First to install enrichment by benzol transfer.
	do	United-Otto	do	Second	July, 1906	50	Foundry and domestic (domestic coke crushed and sized for sale).		
N. Y.	Syracuse	Semet-Solvay	Solvay Process Co.	First Second Third	Jan., 1893 1896 Bet. 1900 and 1903.	12 a 25 a 40	Burning limestone; also iron foundry.	Fuel	First by-product plant in United States. Main purpose originally to obtain ammonia for alkali works.
	Geneva	do	The Empire Coke Co.	First Second	Aug., 1904 1909	30 a 46	Foundry and domestic.	Illuminating	
	Buffalo	United-Otto	Lackawanna Steel Co.	First	May, 1904	b 564	Blast furnace	Fuel gas	First used stamped coal, but changed to top-charging, 1907.
	do	Rothberg	do	do		282	do	do	
Ohio	Hamilton	Otto-Hoffmann	Hamilton Otto Coke Co.	do	Apr., 1901	50	Mostly domestic; some foundry. Installed crushing outfit 1905.	Illuminating gas for Hamilton: also power gas and fuel gas.	
	do	United-Otto	do	Second	1909	50	Blast furnace	do	
	Cleveland	Rothberg	Cleveland Furnace Co.	do	Oct., 1907	25	do	do	Plant closed down March, 1908.
	do	Semet-Solvay	do	Third	1910	49		Illuminating	Originally 80 Rothberg ovens; now operated by the Semet-Solvay Co.
Pa.	Dunbar	do	The Semet-Solvay Co.	First Second	Aug., 1896 July, 1903	50 60	Blast furnace	Fuel gas	
	Chester	do	The Philadelphia Suburban Gas & Electric Co.	First	Apr., 1904	40	Blast furnace	Illuminating and fuel	
	South Sharon	United-Otto	Carnegie Steel Co.	do	July, 1903	212	do	Fuel	
	Glassport	Otto-Hoffmann	Pittsburgh Gas & Coke Co.	do	Feb., 1897	120	Blast furnace and domestic. Installed a crushing outfit in 1905.	Illuminating gas and fuel gas to McKeesport.	
	Johnstown	do	Cambria Steel Co.	do	Nov., 1895	60	Blast furnace	Fuel gas and power gas	
	do	United-Otto	do	Second	Mar., 1899	100	do	do	
	do	do	do	Third	Sept., 1904	100	do	do	
	do	do	do	Fourth	Feb., 1907	112	do	do	

[a] Increased to.

[b] Contracted for, 188 completed.

Complete list of by-product and retort coke-oven plants of the United States, January 1, 1912—Continued.

State.	Town.	System.	Name of company owning plant.	Number of installments.	Date put in operation.	Number of ovens.	Uses of coke.	Uses of surplus gas.	Remarks.
Pa	Lebanon	Semet-Solvay	Pennsylvania Steel Co.	First	July, 1904	90	Blast furnace	Semet-Solvay Co. delivers surplus gas to Pennsylvania Steel Co., which sells it to American Iron & Steel Mfg. Co. for use in heating furnaces and gas engine. Also 4 gas engines 1,200 H. P. each, furnishing power for generating electricity to operate Cornwall Ore Banks, at Lebanon, Pa.	This last gas-engine installation is the largest one in the United States using coke-oven gas.
	do	Otto-Hoffmann	Lackawanna Iron & Steel Co.	do	Mar., 1903	[a] 228	do	Fuel gas	Went back to top-charging since resumption in September, 1905. The 5 Rothberg ovens were shut down in August, 1903, and have since been dismantled.
	do	Rothberg	do	do	May, 1903	5			
	Steelton	Semet-Solvay	Pennsylvania Steel Co.	do	Jan., 1907	120	Blast furnace	Fuel gas	
	South Bethlehem.	Didier	Lehigh Coke Co	do	Not completed.	300			
W. Va	Benwood	Semet-Solvay	National Tube Co	do	Oct., 1898	60	Blast furnace	Fuel gas	
				Second	Mar., 1901	60	do	do	
Wis	Milwaukee	do	Milwaukee Coke & Gas Co.	First	Mar., 1904	80	Blast furnace, foundry, and domestic.	Illuminating and fuel	
	do	do	do	Second	Mar., 1906	80			

[a] 4 ovens abandoned in 1911.

NOTES.—1. Of the 14 plants of Semet-Solvay ovens in the United States, 2 are owned by the Solvay Process Co. and the other 12 are operated by the Semet-Solvay Co., the coke produced being turned over to the company whose name appears as owner.

2. Tar and ammonia are recovered as by-products from all of the plants included in the above table.

IMPORTS AND EXPORTS.

IMPORTS.

The following table gives the quantity and value of coke imported and entered for consumption in the United States from 1906 to 1911, inclusive. In the reports of the Bureau of Statistics of the Department of Commerce and Labor, from which these figures are obtained, the quantities are expressed in long tons of 2,240 pounds. These have been reduced to short tons in order to make them conform to the standard unit of this report.

Coke imported and entered for consumption in the United States, 1906–1911, in short tons.

1906	147, 819	$570, 150	1909	191, 253	$736, 120
1907	135, 968	596, 366	1910	172, 716	625, 130
1908	147, 427	606, 294	1911	77, 923	254, 455

EXPORTS.

The quantity of coal exported from the United States increased steadily from 1900 to 1907, but each year since that time it has alternately decreased and increased, the exports in 1910 being slightly less than in 1909 and those in 1911 being a little more than in 1910. The exports during the last six years are shown in the following table, the quantities being reduced to short tons:

Coke exported from the United States since 1906, in short tons.

1906	857, 013	$2, 753, 551	1909	1, 002, 916	$3, 232, 673
1907	979, 652	3, 206, 793	1910	984, 562	3, 053, 293
1908	695, 434	2, 161, 032	1911	1, 023, 839	3, 215, 990

IMPORTS OF COAL-TAR PRODUCTS.

It has been contended that the development of the by-product coking industry would have shown more rapid progress if markets for the by-products were assured. This contention pertains principally to the coal tar and its products, as there is no difficulty in disposing of the surplus gas and there is practically at all times a fair demand for ammonia. The total value of the domestic coal tar obtained in 1911 amounted to $1,638,314, and the value of the coal-tar products imported into this country, including the duty paid, was $11,709,053. The values of imports in all cases are at point of shipment, and do not include ocean freights, commissions, and other expenses. Considering this factor it is probable that the consumer has paid about $16,000,000 for these importations. The kinds of coal-tar products imported, the value thereof, and the amount of duty paid on each during the last five years, are shown in the following table:

Coal-tar products imported into the United States, 1907–1911.

Year.	Salicylic acid.		Alizarin and colors or dyes, natural and artificial.		Aniline salts.		Coal-tar colors or dyes, not specially provided for.	
	Value.	Duty.	Value.	Duty.	Value.	Duty.	Value.	Duty.
1907	$1,240	$489	$782,368	Free.	$667,758	Free.	$5,830,651	$1,749,196
1908	1,183	345	752,386	Free.	450,891	Free.	4,573,217	1,371,965
1909	....	....	1,191,874	Free.	553,503	Free.	6,431,767	1,929,530
1910	....	....	430,393	Free.	501,369	Free.	5,867,331	1,760,098
1911	3,480	915	996,794	Free.	410,193	Free.	6,444,595	1,933,379

Coal-tar products imported into the United States, 1907–1911—Continued.

Year.	Coal tar, all preparations, not colors or dyes.		Coal-tar products not medicinal, not dyes, known as benzol, toluol, etc.		Total.	
	Value.	Duty.	Value.	Duty.	Value.	Duty.
1907	$911,096	$182,219	$653,288	Free.	$8,846,401	$1,931,904
1908	717,556	143,511	549,352	Free.	7,044,585	1,515,821
1909	693,608	138,768	960,724	Free.	9,831,476	2,068,298
1910	594,252	118,849	962,232	Free.	8,355,577	1,878,947
1911	659,407	131,881	1,128,409	Free.	9,642,878	2,066,175

PRODUCTION OF COKE BY STATES.

ALABAMA.

Notwithstanding the decrease of 487,506 short tons in Alabama's output of coke in 1911 as compared with 1910, the State once more took second place among the coke-producing States, displacing West Virginia, which had held it for six consecutive years. Prior to 1906 the two States were close rivals for that distinction, which alternated almost regularly between them.

On account of Alabama's remarkable resources in iron ore, limestone, and coal, and her ability to produce pig iron more cheaply than it can be made anywhere else in the world, the State assumes relatively greater importance in years of depression in the iron trade than when demand is brisk and prices high. The former condition obtained in 1911, and although Alabama's production was less than in 1910, the decrease in iron production and in the manufacture of coke was not so great as in some of the other States. West Virginia, whose coke product has no local outlet, but is sent out of the State to markets where it has to compete with cokes from other States, showed a decrease in coke output in 1911 amounting to 1,512,801 short tons, and reducing the total of the State to 2,291,049 tons. The production of Alabama decreased from 3,249,027 tons in 1910 to 2,761,521 in 1911, a loss of 487,506 tons, but exceeding the output of West Virginia by a little over 470,000 tons. The value of Alabama's coke production in 1911 was $7,593,594, against $9,165,821 in 1910, a decrease of $1,572,227, or 17.2 per cent.

The average price per ton declined from $2.82 to $2.75. The average price for West Virginia coke in 1911 was $1.85 per ton.

Still another comparison may be made between Alabama's coke production and that of West Virginia. It is well known that the average quality of West Virginia's coal exceeds that of Alabama, yet in 1911 the yield of coal in coke in Alabama's operations was 62.6 per cent and in West Virginia 60.4. A part of this difference is undoubtedly due to the fact that in Alabama 340 by-product ovens were in operation in 1911, from which the output amounted to 669,433 short tons of coke, or 24.24 per cent of the total output of the State. In West Virginia there were 120 retort ovens in operation in 1911 and their output was 165,099 short tons of coke, or 7.21 per cent of the total product. The 340 retort ovens in Alabama consisted of 240 Semet-Solvay ovens at Ensley and 40 at Tuscaloosa, which have been in operation for several years, and 60 Koppers ovens, completed during 1911 by the Woodward Iron Co., at Woodward. An additional plant of 280 Koppers ovens was under construction at the close of 1911 at Corey for the Tennessee Coal, Iron & Railroad Co. This was the only new construction work in progress at the end of the year. There were 44 establishments in Alabama in 1911—an increase of 1 over 1910. The number of ovens in existence at the close of 1911 was 10,121, a decrease of 11 as compared with 1910, for whereas 60 retort ovens were added to the equipment in 1911, 71 beehive ovens were abandoned. Of the 44 establishments in Alabama in 1911, 14, with a total of 2,474 ovens, were idle throughout the year. In addition to these there were 330 ovens, portions of other establishments, which were idle during the entire year. The number of active ovens was therefore 7,317, and the average production from them in 1911 was 377 short tons, against 9,614 active ovens in 1910, with an average production per oven of 338 tons.

The principal coal beds of Alabama which furnish the coal for coke making are the Pratt, the Mary Lee, and the Blue Creek, all of which are in the Warrior Basin, and the mining operations are in Jefferson, Walker, and Tuscaloosa counties. Some coking coal is also produced from the Buck or Blocton No. 1 bed, in Bibb County.

The production of coke in Alabama in 1880, 1890, 1900, and from 1907 to 1911 is shown in the following table:

Statistics of the manufacture of coke in Alabama, 1880–1911.

Year.	Establishments.	Ovens.		Coal used (short tons).	Coke produced (short tons).	Total value of coke at ovens.	Value of coke at ovens per ton.	Yield of coal in coke (per cent).
		Built.	Building.					
1880	4	316	100	106,283	60,781	$183,063	$3.01	57.0
1890	20	4,805	371	1,809,964	1,072,942	2,589,447	2.41	59.0
1900	30	6,529	690	3,582,547	2,110,837	5,629,423	2.67	58.9
1907	43	9,889	50	4,973,296	3,021,794	9,216,194	3.05	61.0
1908	45	10,103	0	3,875,791	2,362,666	7,169,901	3.04	61.0
1909	43	10,061	0	5,080,764	3,085,824	8,068,267	2.61	60.7
1910	43	10,132	340	5,272,322	3,249,027	9,165,821	2.82	61.6
1911	44	[a]10,121	[b]280	4,411,298	2,761,521	7,593,594	2.75	62.6

[a] Includes 280 Semet-Solvay and 60 Koppers ovens.

[b] Koppers by-product ovens.

Out of a total of 4,411,298 short tons of coal made into coke in Alabama in 1911, about 55 per cent, or 2,420,117 tons, was washed slack. The washed run-of-mine coal used was a little over one-half the quantity of washed slack, or 1,295,109 tons. The unwashed coal used for coke making in Alabama in 1911 was 693,135 tons of unwashed mine-run and 2,937 tons of unwashed slack. The total quantity of washed coal used was 3,715,226 short tons, or about 84.2 per cent of the total quantity of coal made into coke.

The character of the coal used in the manufacture of coke in Alabama in 1890, 1900, and for the last five years, is shown in the following table:

Character of coal used in the manufacture of coke in Alabama, 1890–1911, in short tons.

Year.	Run of mine.		Slack.		Total.
	Unwashed.	Washed.	Unwashed.	Washed.	
1890	1,480,669	0	206,106	123,189	1,809,964
1900	1,729,882	152,077	165,418	1,535,170	3,582,547
1907	1,020,907	1,697,913	27,433	2,227,043	4,973,296
1908	548,093	1,457,360	53,218	1,817,120	3,875,791
1909	713,992	2,153,801	0	2,212,971	5,080,764
1910	771,931	1,308,085	0	3,192,306	5,272,322
1911	693,135	1,295,109	2,937	2,420,117	4,411,298

COLORADO AND UTAH.

As there are but two establishments engaged in the manufacture of coke in Utah, and both are owned by one company, the statistics of production in that State are included with those of Colorado. There were 1,177,023 short tons of coke produced in the two States in 1911, the value of which was $3,880,710, against 1,346,211 short tons, valued at $4,273,579, in 1910. The decrease in 1911 from 1910 was 169,188 short tons, or 12.6 per cent, in quantity and $392,869, or 9.2 per cent, in value. For some reason which did not seem apparent the average price for coke in Colorado and Utah in 1910 was considerably below that of the three preceding years and of the average price obtained in 1911. In 1908 and 1909 the average price per ton of coke in Colorado and Utah was $3.30. It dropped to $3.17 in 1910, and advanced again to $3.30 in 1911. Considerable quantities of Colorado coke are produced at plants that form part of establishments which include coal mining, coke making, and the manufacture of iron and steel, or the smelting and refining of the precious and semi-precious metals. In these cases the placing of values on the coke product is simply a matter of bookkeeping, and the variations which appeared from 1909 to 1910 and from 1910 to 1911 may have been more apparent than real.

All of the ovens in Colorado and Utah are of the beehive type. They are distributed among 18 establishments, 16 in Colorado and 2 in Utah. There were 235 ovens abandoned in 1910 and 5 more in 1911, reducing the total number from 4,700 in 1909 to 4,460 in 1911. Of the 18 establishments in 1911, 8 (7 in Colorado and 1 in Utah) were idle during the entire year. The idle plants had a total of 1,018 ovens, in addition to which there were 933 ovens, portions of other establishments, which were idle during the year, making a total of 1,951 idle ovens during 1911.

The statistics of the manufacture of coke in Colorado and Utah in 1880, 1890, 1900, and for the last five years are shown in the following table:

Statistics of the manufacture of coke in Colorado and Utah, 1880–1911.

Year.	Establishments.	Ovens.		Coal used (short tons).	Coke produced (short tons).	Total value of coke at ovens.	Value of coke at ovens per ton.	Yield of coal in coke (per cent).
		Built.	Building.					
1880	1	200	50	51,891	25,568	$145,226	$5.68	49.0
1890	8	916	30	407,023	245,756	959,246	3.90	60.0
1900	14	1,692	0	997,861	618,755	1,746,732	2.82	62.0
1907	18	4,683	50	2,388,911	1,421,579	4,747,436	3.34	59.5
1908	18	4,705	0	1,546,044	982,291	3,238,888	3.30	63.5
1909	18	4,700	0	1,984,985	1,251,805	4,135,931	3.30	63.1
1910	18	4,465	0	2,069,266	1,346,211	4,273,579	3.17	65.1
1911	18	4,460	0	1,810,335	1,177,023	3,880,710	3.30	65.0

The total quantity of coal used in the manufacture of coke in Colorado and Utah in 1911 was 1,810,335 short tons, of which 1,025,031 tons were run of mine and 785,304 tons were slack. All of the run-of-mine coal and 356,333 tons of slack coal used was washed before being charged into the ovens, and 428,971 tons of slack coal were used unwashed.

The character of the coal used in the manufacture of coke in Colorado and Utah in 1890, 1900, and for the last five years is shown in the following table:

Character of coal used in the manufacture of coke in Colorado and Utah, 1890–1911.

Year.	Run of mine.		Slack.		Total.
	Unwashed.	Washed.	Unwashed.	Washed.	
1890	36,058	0	395,023	0	431,081
1900	229,311	0	316,527	452,023	997.861
1907	2,956	676,226	1,055,189	654,540	2,388,911
1908	0	237,540	407,533	900,971	1,546,044
1909	117,446	1,155,233	398,762	313,544	1,984,985
1910	252,468	836,067	429,728	551,003	2,069.266
1911	0	1,025,031	428,971	356,333	1,810,335

GEORGIA.

Two counties, Dade and Walker, in the extreme northwest corner of Georgia, contain the only coal in the State. Portions of each of these counties are underlain by the coal measures of the Appalachian coal fields. The Walden Basin of Tennessee crosses Dade County in Georgia, and, extending southwestward, becomes the Blount Mountain and Warrior basins in Alabama. The Walker County deposit is an extension northeast of the Lookout Mountain Basin, a narrow outlying area that has its principal development in Etowah County, Ala. The coals of both basins are of coking quality, those of Dade County being confined to the Lookout sandstone. These are generally thinner than the principal coals of the overlying Walden sandstone. The production at the present time is chiefly from the coals of the Lookout Mountain Basin.

The screened coal from the Walker County mines is in good demand as a steam fuel and for the bunker trade, so that only the slack or fine coal passing through the screen is available for coke making. Most of the impurities pass through with the slack, which necessitates washing the slack before charging it into the ovens. A considerable portion of the fixed carbon is burned off in the coking process, for whereas the mine-run coal has a high content in fixed carbon (80 per cent) the yield of coal in coke is less than 55 per cent. A small quantity of coke was made in Dade County in 1910 (the first in three years) and was from mine-run coal. None was made in 1911.

The total quantity of coke produced in Georgia in 1911 was 37,553 short tons, a decrease of 6,261 tons compared with 1910. The manufacture of coke, like the production of coal in Georgia, has shown a decreasing tendency during the last five years, due principally to the fact that the State government has withdrawn the convicts who were formerly employed by contract in the mines and at the ovens, and operators have not been able to procure the free labor necessary to operate the mines and ovens to capacity, the coal-mining districts being somewhat remote and the supply of local labor insufficient.

The value of the coke product of Georgia decreased from $173,049 in 1910 to $135,190 in 1911, and the average price per ton declined from $3.95 to $3.60.

The statistics of the manufacture of coke in Georgia in 1880, 1890, 1900, and from 1907 to 1911 are shown in the following table:

Statistics of the manufacture of coke in Georgia, 1880–1911.

Year.	Establishments.	Ovens.		Coal used (short tons).	Coke produced (short tons).	Total value of coke at ovens.	Value of coke at ovens per ton.	Yield of coal in coke (per cent).
		Built.	Building.					
1880	1	140	40	63,402	38,041	$81,789	$2.15	60.0
1890	1	300	0	170,388	102,233	150,995	1.48	60.0
1900	2	480	0	140,988	73,928	210,646	2.85	52.4
1907	2	350	0	136,031	74,934	315,371	4.21	55.1
1908	2	350	0	71,452	39,422	137,524	3.72	55.2
1909	2	350	0	86,290	46,385	159,334	3.44	53.8
1910	2	350	0	80,019	43,814	173,049	3.95	54.8
1911	2	225	0	72,677	37,553	135,190	3.60	51.7

ILLINOIS.

Illinois is one of the few States whose production of coke in 1911 exceeded that of 1910. As, however, the production in the State was confined to the operations of two companies, the details of the operations are included with the production of other States. Illinois now ranks fourth among the coke-producing States, this prominence having been obtained through the operations of 200 Semet-Solvay by-product ovens at South Chicago and of 280 Koppers regenerative by-product ovens at Joliet. There were six establishments in the State at the close of 1911, but two of them were idle and two others were incomplete. The incomplete establishments consist of one plant of 13 Semet-Solvay ovens building at Waukegan for the North Shore Gas Co. and 35 Koppers ovens building at Joliet for the Coal Products Manufacturing Co. Most of the coal for these ovens is drawn from West Virginia mines, the plant of 280 Koppers ovens at Joliet using 80 per cent of Pocahontas coal mixed with 20 per cent of Illinois coal. This mixture is found to make an entirely satisfactory coke. The yield of coal in coke in 1911 was 77.1 per cent as against 76.8 per cent in 1910 and 75.9 per cent in 1909.

The statistics of the manufacture of coke in Illinois during the last five years are shown in the following table:

Statistics of the manufacture of coke in Illinois, 1907–1911.

Year.	Establishments.	Ovens.		Coal used (short tons).	Coke produced (short tons).	Total value of coke at ovens.	Value of coke at ovens per ton.	Yield of coal in coke (per cent).
		Built.	Building.					
1907	5	309	280	514,983	372,697	1,737,464	4.66	72.3
1908	6	430	140	503,359	362,182	1,538,952	4.25	72.0
1909	5	468	40	1,682,122	1,276,956	5,361,510	4.20	75.9
1910	5	508	0	1,972,955	1,514,504	6,712,550	4.43	76.8
1911 [a]	6	[b] 506	[c] 48	....	....	....	....	....

[a] Production included in other States.
[b] Includes 200 Semet-Solvay, 280 Koppers, and 24 Belgian ovens.
[c] Includes 13 Semet-Solvay and 35 Koppers ovens.

INDIANA.

During 1911, 490 of the 560 ovens building for the United States Steel Corporation at Gary were completed. The operation of those 490 ovens, together with the 50 United Otto ovens constructed for the Citizens' Gas Co., at Indianapolis, advanced Indiana as a coke-producing State from seventeenth to sixth place. Ten beehive ovens at Black Creek and 36 of the same type at Ayrshire were not operated in either 1910 or 1911. Most of the coal for the ovens at Gary and at Indianapolis is drawn from West Virginia mines.

KANSAS.

The only coke made in Kansas during 1911 was a small quantity produced in underground ovens operated in connection with the State penitentiary mines at Lansing. The industry has never been of great importance in the State, and the largest production (20,902 tons) was obtained in 1902. That product was made at ovens which were operated in connection with the zinc works and was used in the smelting operations.

The statistics of the manufacture of coke in Kansas in 1880, 1890, 1900, and from 1907 to 1911 are shown in the following table:

Statistics of the manufacture of coke in Kansas, 1880–1911.

Year.	Establishments.	Ovens.		Coal used (short tons).	Coke produced (short tons).	Total value of coke at ovens.	Value of coke at ovens per ton.	Yield of coal in coke (per cent).
		Built.	Building.					
1880	2	6	0	4,800	3,070	$6,000	$1.95	64.0
1890	7	68	0	21,809	12,311	29,116	2.37	56.0
1900	9	91	0	10,303	5,948	14,985	2.52	57.7
1907	6	83	0	11,392	6,274	19,837	3.16	55.0
1908	6	67	0	3,790	2,497	8,011	3.21	65.9
1909	6	67	0	0	0	0	0	0
1910	6	71	0	(a)	(a)	(a)	(a)	(a)
1911	3	53	0	(a)	(a)	(a)	(a)	(a)

a Included with other States having less than three producers.

KENTUCKY.

Kentucky is the only one of the United States whose coal supplies are drawn from any two of the great fields. The eastern counties of the State are underlain by the coal measures of the Appalachian region, and the southern extremity of the eastern interior, or Illinois-Indiana field, is worked extensively in the western part of Kentucky. Coke has been made from coal mined in both the eastern and the western parts of the State; but although the coals of the eastern counties are in large part included among the high-grade coking coals of the Appalachian field, and although little or no coke is made from the coals of the eastern interior field in Illinois or Indiana, the larger part of the coke made in Kentucky has been made in the western district. In 1911 there were 8 establishments in the State with a total of 577 ovens, an increase of 2 establishments and 82 ovens over 1910. Of the 8 establishments, 3, with a total of 254 ovens, were idle throughout the year. Two of the idle establishments have not been in operation for three years. The new construction in 1911 consisted of 300 beehive ovens building for the Wisconsin Steel Co. at Benton, in Harlan County. The production in 1911 amounted to 66,099 short tons, valued at $134,862, against 53,857 short tons, valued at

$120,554 in 1910. The increase in 1911 was 12,242 short tons, or 22.7 per cent, in quantity, and $14,308, or 11.9 per cent, in value. The average price per ton declined from $2.24 in 1910 to $2.04 in 1911, but the yield of coal in coke increased from 51.7 to 55.9 per cent. The production in the State, while not important, has increased in each of the last three years. The quantity of coal used in coke making in Kentucky in 1911 was 118,255 short tons. At the ovens in the eastern part of the State the coal used consists of about 25 per cent unwashed slack and 75 per cent unwashed run of mine. At the ovens in the western part of the State only washed slack is used.

The following table gives the statistics of production of coke in Kentucky in 1880, 1890, 1900, and for the last five years:

Statistics of the manufacture of coke in Kentucky, 1880–1911.

Year.	Establishments.	Ovens.		Coal used (short tons).	Coke produced (short tons).	Total value of coke at ovens.	Value of coke at ovens per ton.	Yield of coal in coke (per cent).
		Built.	Building.					
1880	5	45	0	7,206	4,250	$12,250	$2.88	59.0
1890	9	175	103	24,372	12,343	22,191	1.80	51.0
1900	5	458	3	190,268	95,532	235,505	2.47	50.2
1907	6	495	0	129,538	67,068	157,288	2.35	51.7
1908	6	495	0	(a)	37,827	(a)	(a)	(a)
1909	6	494	0	89,083	46,371	101,257	2.18	52.0
1910	6	495	0	104,103	53,857	120,554	2.24	51.7
1911	8	577	300	118,255	66,099	134,862	2.04	55.9

a Included with other States having less than three producers.

MISSOURI.

Coke making in Missouri has never been an important industry and, as in Kansas, has been limited to the coking of a small quantity of Pittsburg (Kans.) slack, the coke being used at the zinc smelters. All of the ovens have now been abandoned.

MONTANA.

Coals which possess coking qualities are found in Montana, but the attempts to utilize them for that purpose have not met with marked success. There are four establishments in the State, with a total of 451 ovens, but all of them were idle during 1911. All the 451 ovens are of the beehive type.

In the following table are given the statistics of production of coke in Montana in 1884, when the first production was reported, and in 1890, 1900, and since 1907:

Statistics of the manufacture of coke in Montana, 1884–1911.

Year.	Establishments.	Ovens.		Coal used (short tons).	Coke produced (short tons).	Total value of coke at ovens.	Value of coke at ovens per ton.	Yield of coal in coke (per cent).
		Built.	Building.					
1884	3	5	12	165	75	$900	$12.00	46.0
1890	2	140	0	32,148	14,427	125,655	8.71	45.0
1900	3	342	111	108,710	54,731	337,079	6.16	50.3
1907	5	567	15	68,948	40,714	295,174	7.25	59.0
1908	5	551	3	59,268	34,573	(a)	(a)	58.3
1909	5	551	3	82,993	37,069	(a)	(a)	44.7
1910	4	451	3	(a)	(a)	(a)	(a)	(a)
1911	4	451	3	0	0	0	0	0

a Included with other States having less than three producers.

NEW MEXICO.

All the coke made in New Mexico is from coal mined from the Raton field in Colfax County. This field is the southern part of the Raton Mesa coal region, which consists of the Raton field in New Mexico and the Trinidad field in Colorado. The coal measures are continuous, but the producing areas are separated by a high divide near the Colorado-New Mexico line. A bank of 50 ovens at Waldo, in Santa Fe County, has not been in operation for several years. Slack coal only is used in the manufacture of coke, and as over 25 per cent of the total output of the mines yielding coking coal goes into slack, an ample supply of fuel for the coke ovens is available.

All the coal used for coke making in New Mexico is washed slack from the mines at Dawson, Gardiner, and Koehler. The washed slack used in 1911 was 620,639 short tons, which yielded 381,927 tons of coke, valued at $1,240,963. The production in 1910 was 401,646 short tons, valued at $1,306,136. The decrease of approximately 20,000 tons in 1911 was in sympathy with the decreased production of coal and the smaller quantity of slack available for the coke ovens. The average price per ton of coke in New Mexico in 1911 was the same as in 1910, $3.25.

The 4 establishments in the State include a total of 1,030 ovens, of which 50 were idle in 1909, 1910, and 1911. There was no new construction in 1910 and none was in progress at the end of the year. All the ovens in the State are of the beehive type except that of 570 ovens at Dawson 446, although of beehive type, are provided with underflues through which the gases distilled from the coal are conveyed to a large flue back of the ovens and thence to the power house. The heat obtained from the oven gases renders the use of other fuel in the power plant unnecessary. The power plant, in addition to furnishing power for the operation of the mines, for ventilation, electric haulage, the coal crusher, washery, etc., furnishes also steam heat to the offices, commissary, hotel, hospital, and theater, and electric light for the entire city of Dawson.

The statistics of production in 1882, 1890, 1900, and from 1907 to 1911 are shown in the following table:

Statistics of the manufacture of coke in New Mexico, 1882–1911.

Year.	Establishments.	Ovens.		Coal used (short tons).	Coke produced (short tons).	Total value of coke at ovens.	Value of coke at ovens per ton.	Yield of coal in coke (per cent).
		Built.	Building.					
1882	2	0	12	1,500	1,000	$6,000	$6.00	66.0
1890	2	70	0	3,980	2,050	10,025	4.89	51.5
1900	2	126	0	74,261	44,774	130,251	2.91	60.3
1907	4	896	125	446,140	265,125	840,253	3.17	59.4
1908	4	1,016	0	454,873	274,565	826,780	3.01	60.4
1909	4	1,030	0	694,390	373,967	1,099,694	2.94	53.9
1910	4	1,030	0	651,494	401,646	1,306,136	3.25	61.6
1911		1,030	0	620,639	381,927	1,240,963	3.25	61.5

NEW YORK.

All the coke manufactured in New York is the product of by-product recovery ovens. There are 188 Otto-Hoffman ovens and 282 Rothberg ovens operated by the Lackawanna Steel Co., at Buffalo; 40 Semet-Solvay ovens operated by the Semet-Solvay Co., at Solvay, near Syracuse; and 46 Semet-Solvay ovens operated by the Empire

Coke Co., at Empire. The two plants of the Lackawanna Steel Co. are considered as two separate establishments, so that the production is from four establishments with a total of 556 ovens. The production in 1911 amounted to 686,172 short tons, valued at $2,883,990, against 652,459 tons, valued at $2,635,873, in 1910. From this it appears that New York shared in the general increase of production in by-product ovens, the gain in 1911 amounting to 33,713 short tons, or 5.2 per cent, in quantity, and $248,117, or 9.4 per cent, in value. The average price per ton advanced from $4.04 in 1910 to $4.20 in 1911. The quantity of coal used in 1910 was 910,293 short tons, and in 1911 it was 955,067 tons. The yield of coal in coke was 71.7 per cent in 1910 and 71.8 per cent in 1911. As New York is entirely outside the coal-producing area, all of the coal used for coke making in the State is drawn from the mines of Pennsylvania. It will be noted, however, that in Pennsylvania, where most of the coke is produced in beehive ovens, the yield of coal in coke is 66.7 per cent, while in New York it is nearly 72 per cent. Most of the coal used in New York (about 93 per cent) is run of mine, of which about 85 per cent is unwashed and 15 per cent is washed.

The statistics of the manufacture of coke in New York in 1910 and 1911 are shown in the following table:

Statistics of the manufacture of coke in New York in 1910 and 1911.

Year.	Establishments.	Ovens.		Coal used (short tons).	Coke produced (short tons).	Total value of coke at ovens.	Value of coke at ovens per ton.	Yield of coal in coke (per cent).
		Built.	Building.					
1910	4	556	0	910,293	652,459	$2,635,873	$4.04	71.7
1911	4	[a]556	0	955,067	686,172	2,883,990	4.20	71.8

[a] Includes 188 Otto-Hoffman, 282 Rothberg, and 86 Semet-Solvay ovens.

OHIO.

The coals of Ohio belong to the Appalachian province, and most of the beds are correlated with those of Pennsylvania and West Virginia to the east and southeast. But although the bituminous and semibituminous coals of Pennsylvania and West Virginia include the highest grade coking coals in the United States, and although those two States are the first and second in rank as coke producers, the coals seem to lose their coking qualities as the beds extend westward, and a large part of the coke made in Ohio is from coal brought from West Virginia to by-product retort ovens at Hamilton, near Cincinnati, and at Cleveland. On the other hand, some of the coal mined in Ohio is a good blast-furnace fuel in the raw state, and this obviates the necessity of coking. When used raw, however, the coal is usually mixed with coke.

Ohio ranks fourth among the States as a coal producer, but only fourteenth in the manufacture of coke, and until 1905, when the first installation of by-product ovens was put in operation, Ohio could lay claim to little importance as a producer of coke.

As the larger part of Ohio's coke is made in by-product ovens that State like the others where similar conditions obtain showed an increased production in 1911. The increase, however, was relatively small. In 1910 Ohio's coke production amounted to 282,315 short tons, valued at $911,987; in 1911 it amounted to 311,382 short tons, valued at $961,904, the increase in production amounting to 29,067 short tons, and the value to $49,917.

In 1911 there were 8 establishments in the State, with a total of 496 ovens, of which 2 establishments with 75 ovens were idle. In addition to these, 1 other establishment reported 64 of its ovens idle, so that the total number of idle ovens was 139. The number of establishments and the number of ovens at the close of 1911 were the same as in 1910. There was no new construction work in progress at the end of either year. The average price per ton for Ohio coke which had advanced from $3.07 in 1909 to $3.23 in 1910, declined again in 1911 to $3.09. All of these prices are considerably higher than those obtained for coke in Pennsylvania and West Virginia. The higher price is because a large part of the coal used for coke making in Ohio is brought from West Virginia mines and the transportation expenses are added to the cost of the coal and consequently to the value of the coke at the works, which are relatively near the points of consumption.

The statistics of the production of coke in Ohio in 1880, 1890, and 1900, and for the last five years are shown in the following table:

Statistics of the manufacture of coke in Ohio, 1880–1911.

Year.	Establishments.	Ovens.		Coal used (short tons).	Coke produced (short tons).	Total value of coke at ovens.	Value of coke at ovens per ton.	Yield of coal in coke (per cent).
		Built.	Building.					
1880	15	616	25	172,453	100,596	$255,905	$2.54	58.0
1890	13	443	1	126,921	74,633	218,090	2.92	59.0
1900	8	369	50	115,269	72,116	194,042	2.69	62.5
1907	8	600	50	376,759	270,634	819,262	3.03	71.8
1908	7	481	50	237,448	159,578	491,982	3.08	67.2
1909	7	447	49	340,735	222,711	683,155	3.07	65.4
1910	8	496	0	413,059	282,315	911,987	3.23	68.3
1911	8	[a] 496	0	456,222	311,382	961,904	3.09	68.2

[a] Includes 25 Rothberg, 100 United-Otto, and 49 Semet-Solvay ovens.

The larger part of the coal used in coke making in Ohio being brought as it is from West Virginia, is run of mine used unwashed. In 1911 the unwashed run of mine coal used amounted to 417,101 short tons, and the unwashed slack to 5,504 tons. The washed coal amounted to 33,617 tons nearly equally divided between mine run and slack.

The character of the coal used in the manufacture of coke in Ohio in 1890, 1900, and from 1907 to 1911, is shown in the following table:

Character of coal used in the manufacture of coke in Ohio since 1890, in short tons.

Year.	Run of mine.		Slack.		Total.
	Unwashed.	Washed.	Unwashed.	Washed.	
1890	34,729	0	54,473	37,719	126,921
1900	68,175	0	17,094	30,000	115,269
1907	268,637	45,712	36,514	25,896	376,759
1908	180,458	27,481	6,244	23,265	237,448
1909	293,554	0	12,312	34,869	340,735
1910	333,397	0	12,212	67,450	413,059
1911	417,101	16,574	5,504	17,043	456,622

OKLAHOMA.

Small success has been made in the attempts to manufacture coke from Oklahoma's coal. There are four establishments in the State, and one of them produced a small quantity of coke in 1910, but all four were idle in 1911. The details of the 1910 production are included among other States having less than three producers.

The following table gives the statistics of the manufacture of coke in Oklahoma (Indian Territory) in 1880, 1890, 1900, and from 1907 to 1911:

Statistics of the manufacture of coke in Oklahoma (Indian Territory), 1880–1911.

Year.	Establishments.	Ovens.		Coal used (short tons).	Coke produced (short tons).	Total value of coke at ovens.	Value of coke at ovens per ton.	Yield of coal in coke (per cent).
		Built.	Building.					
1880	1	20	0	2,494	1,546	$4,638	$3.00	62.0
1890	1	80	0	13,278	6,639	21,577	3.25	50.0
1900	3	230	0	79,534	38,141	152,204	3.99	48.0
1907	5	490	50	38,615	19,089	82,447	4.32	49.4
1908	5	486	50	(a)	2,944	(a)	(a)	(a)
1909	5	536	0	0	0	0	0	0
1910	4	408	0	(a)	(a)	(a)	(a)	(a)
1911	4	410	0	0	0	0	0	0

[a] Included with other States having less than three producers.

PENNSYLVANIA.

Pennsylvania stands preeminent among the States in the production of coal and in the manufacture of coke. As a producer of coke Pennsylvania is relatively of greater importance than as a producer of coal, for, whereas, including the production of anthracite, Pennsylvania contributes less than half the entire output of coal in the United States, nearly two-thirds the total production of coke is made within that State. In 1911 the two principal coking districts of Pennsylvania, the Connellsville and the Lower Connellsville districts, both included in the two counties of Fayette and Westmoreland, produced 47.59 per cent of the coke product of the United States. Ever since coke became the principal fuel in the manufacture of iron (it superseded anthracite for this purpose in 1875) the Connellsville district has been the chief source of supply. What is known as the Lower Connellsville district came into existence in 1900, and in its 11 years of life has exhibited a rapidity in development that has outrivaled any coke-making district in the world. The Connellsville Basin proper is included in both Westmoreland and Fayette counties; the Lower Connellsville Basin is entirely in Fayette County, lies southwest of the southern end of the Connellsville Basin, and is separated from it by the Greensburg anticline. The Lower Connellsville district is now the second coke-producing district in the United States and will probably in a few years rival its older neighbor for first place. The year 1911 was the second one in which, since it was first opened, the Lower Connellsville district showed a decrease in the production of coke. In both the Connellsville and the Lower

Connellsville districts all but a very small quantity of the coke is made in beehive ovens or in rectangular ovens in which the process is one of partial combustion, as in the beehive ovens, and without recovery of by-products or utilization of the heat generated in the coking process. With the exception of 110 Semet-Solvay ovens in the Connellsville district all of the by-product recovery ovens in Pennsylvania are outside of the coking-coal mining districts.

The quantity of coke produced in Pennsylvania in 1911 was 21,923,935 tons, valued at $43,053,367 against 26,315,607 short tons, valued at $55,254,599, in 1910. The decrease in 1911, compared with 1910, was 4,391,672 short tons, or 16.7 per cent, in quantity, and $12,201,232, or 22.1 per cent, in value. The average price per ton declined from $2.10 in 1910 to $1.96 in 1911. The average price in 1911 was the lowest since 1904, when it was $1.684.

The quantity of coal consumed in the manufacture of coke in 1911 was 32,875,655 short tons, and as the coke produced amounted to 21,923,935 short tons the average yield of coal in coke was 66.7 per cent, the same average yield as in 1910, when 39,455,785 tons of coal were used in the production of 26,315,607 tons of coke.

In 1911, for the first time in a number of years, the number of ovens abandoned in Pennsylvania exceeded the number of new ovens constructed, and the total number of ovens in existence decreased from 55,656 to 54,904, a difference of 752. The number of coke-making establishments decreased from 288 to 279. Of the 279 establishments in 1911, 66, with a total of 4,816 ovens, were not in operation during the year, and there were 12,461 ovens, portions of plants that were out of blast, making a total of 17,277 idle ovens for the year. Of the 37,627 active ovens, 1,100, or 2.92 per cent, were of the by-product recovery type, and 36,527, or 97.08 per cent, were beehive, rectangular, or other partial combustion types of ovens. The total production from the by-product ovens was 1,493,509 short tons, or an average of 1,358 tons per oven and an average yield of coal in coke of 75.8 per cent. The production from the beehive and similar types of ovens was 20,430,426 tons, an average of 559 tons per oven and an average yield of 66.1 per cent. For further comparisons of the beehive and retort oven practice the reader is referred to the section on the manufacture of coke in by-product ovens.

At the close of 1911 the new work in course of construction consisted of 1,271 ovens, this being the fewest number of ovens building at the close of any year since 1898, when the number was 292. The new ovens building included 204 rectangular, 60 Belgian, and 300 Didier by-product ovens, the last mentioned being constructed for the Lehigh Coke Co. at South Bethlehem. The rectangular (or Mitchell) ovens, which have found greatest favor in the Lower Connellsville district, differ from the beehive oven only in the shape of the oven and not in the process of carbonization of the coal. The chief advantage possessed by the rectangular oven over the beehive is that the coking chamber, being long and narrow, the coke may be pushed from it as from the retort oven and does not have to be drawn from it as from the beehive oven.

The statistics of the production of coke in Pennsylvania for the years 1880, 1890, 1900, and for the last five years are shown in the following table:

Statistics of the manufacture of coke in Pennsylvania, 1880–1911.

Year.	Establishments.	Ovens.		Coal used (short tons).	Coke produced (short tons).	Total value of coke at ovens.	Value of coke at ovens per ton.	Yield of coal in coke (per cent).
		Built.	Building.					
1880	124	9,501	836	4,347,558	2,821,384	$5,255,040	$1.86	65.0
1890	106	23,430	74	13,046,143	8,560,245	16,333,674	1.91	65.6
1900	177	32,548	2,310	20,239,966	13,357,295	29,692,258	2.22	66.0
1907	253	51,364	1,337	39,733,177	26,513,214	67,638,024	2.55	66.7
1908	252	52,606	1,720	23,215,964	15,511,634	32,569,621	2.10	66.8
1909	283	54,506	2,072	36,983,568	24,905,525	50,377,035	2.02	67.3
1910	288	55,656	1,334	39,455,785	26,315,607	55,254,599	2.10	66.7
1911	279	[a] 54,904	[b] 1,271	32,875,655	21,923,935	43,053,367	1.96	66.7

[a] Includes 932 United Otto, 360 Semet-Solvay, 152 Newton-Chambers, 2,574 rectangular, 400 Belgian, 160 waste-heat, and 11 Ramsey ovens.

[b] Includes 204 rectangular, 60 Belgian, and 300 Didier ovens.

By far the larger part of the coal used in coke making in Pennsylvania is unwashed run of mine. The coal mined in the Connellsville districts is an ideal coking coal, and requires no preparation for the coke oven, though some of it is crushed before being charged. Of the 32,875,655 short tons of coal used in 1911 for coke making in Pennsylvania, 27,601,050 tons were unwashed run of mine and 1,029,149 tons were unwashed slack. The washed coal used consisted of 1,958,360 short tons of mine run and 2,287,096 tons of slack.

The character of the coal used in the manufacture of coke in Pennsylvania in 1890, 1895, 1900, 1905, and from 1907 to 1911 has been as follows:

Character of coal used in the manufacture of coke in Pennsylvania since 1890, in short tons.

Year.	Run of mine.		Slack.		Total.
	Unwashed.	Washed.	Unwashed.	Washed.	
1890	11,788,625	303,591	630,195	323,732	13,046,143
1895	13,618,376	34,728	440,869	117,594	14,211,567
1900	17,692,623	647,045	1,300,796	599,502	20,239,966
1905	26,148,696	1,335,631	2,436,621	1,109,397	31,030,345
1907	33,589,751	2,267,142	2,566,090	1,310,194	39,733,177
1908	18,691,073	1,718,944	1,062,478	1,743,469	23,215,964
1909	31,712,482	2,278,927	1,016,576	1,975,583	36,983,568
1910	32,688,029	2,372,115	1,275,348	3,120,293	39,455,785
1911	27,601,050	1,958,360	1,029,149	2,287,096	32,875,655

PRODUCTION BY DISTRICTS.

In previous chapters of this series of reports it has been customary to consider the production of coke in Pennsylvania according to certain well-defined districts. These divisions are based to some extent upon geographic boundaries, but also upon the quality of the coal mined and the coke produced. Each district has been more fully described in some of the preceding volumes, but the following brief statement regarding the territory included in the different coking districts is repeated here for the sake of convenience.

The Allegheny Mountain district includes the ovens along the line of the Pennsylvania Railroad from Gallitzin eastward over the crest of the Alleghenies to a point beyond Altoona. The Allegheny Valley district formerly included the coke works of Armstrong and Butler counties and one of those in Clarion County, the other ovens in the latter county being included in the Reynoldsville-Walston district. All but two of the Allegheny Valley plants have been abandoned, and the production previous to 1908 has been included in that of the Pittsburgh district. During 1911 but one of these plants was in operation. What was previously known as the Beaver district included the ovens in Beaver and Mercer counties, but all the ovens in Beaver County have been abandoned, those formerly operated by the Semet-Solvay Co. in Mercer County have been abandoned, and the operations of the one establishment of United-Otto ovens at South Sharon are now also included in the Pittsburgh district. The Blossburg and the Broadtop districts embrace the Blossburg and the Broadtop coal fields. The ovens of the Clearfield-Center district are chiefly in the two counties from which it derives its name. A few ovens in Elk County have been included in the Clearfield-Center district. The Connellsville district is the well-known region of western Pennsylvania in Westmoreland and Fayette counties, extending from just south of Latrobe to Fairchance. The Lower Connellsville region is entirely in Fayette County and southwest of the Connellsville Basin proper, from which it is separated by the Greensburg anticline. It embraces the recent developments in the vicinity of Uniontown and is now the second producing district of the State. The Greensburg, Irwin, Pittsburgh, and Reynoldsville-Walston districts include the ovens near the towns which have given the names to these districts. The Upper Connellsville district, sometimes called the Latrobe district, is near the town of Latrobe. The Semet-Solvay ovens at Chester, Steelton, and Lebanon, and the United-Otto ovens at Lebanon are in what has been designated as the Lebanon-Schuylkill district, the production of which has previously been combined with that of the Broadtop district. Owing to the number of establishments being less than three in several of the districts during 1911 the only ones for which separate statistics are published are: Allegheny Mountain, Connellsville, Greensburg, Lower Connellsville, Pittsburgh, Reynoldsville-Walston, and Upper Connellsville districts.

Coke production in Pennsylvania in 1910 and 1911, by districts.

1910.

District.	Establishments.	Ovens.		Coal used (short tons).	Coke produced (short tons).	Total value of coke at ovens.	Value of coke per ton.	Yield of coal in coke (per cent).
		Built.	Building.					
Allegheny Mountain	25	[a] 2,523	0	1,431,309	1,016,487	$2,533,826	$2.49	71.0
Allegheny Valley	2	52	0	0	0	0	0	0
Connellsville	118	[b] 24,481	[c] 206	17,205,615	11,459,601	23,121,556	2.02	66.6
Greensburg	6	1,940	[d] 100	1,503,241	953,188	2,009,093	2.11	63.4
Lower Connellsville	73	[e] 14,805	[f] 668	12,130,425	8,219,492	16,048,675	1.95	67.8
Pittsburgh	13	[g] 3,734	0	3,388,964	2,151,889	5,313,119	2.47	63.5
Reynoldsville - Walston	9	2,781	0	1,483,645	870,046	1,972,927	2.27	58.7
Upper Connellsville	21	[h] 2,850	[i] 60	780,888	504,876	956,422	1.89	64.7
Other districts [j]	21	[k] 2,490	[l] 300	1,531,698	1,140,028	3,298,981	2.89	74.4
Total	288	55,656	1,334	39,455,785	26,315,607	55,254,599	2.10	66.7

1911.

Allegheny Mountain	25	[a] 2,475	0	1,182,516	826,726	$2,037,953	$2.47	69.9
Connellsville	112	[m] 23,879	227	14,420,328	9,565,013	18,471,506	1.93	66.3
Greensburg	7	[n] 2,040	0	1,142,361	747,654	1,451,130	1.94	65.4
Lower Connellsville	71	[o] 14,857	[p] 654	10,771,495	7,354,736	12,998,192	1.77	68.3
Pittsburgh	12	[q] 3,737	0	2,322,422	1,449,934	3,228,508	2.23	62.4
Reynoldsville - Walston	10	[r] 2,881	0	1,427,896	818,942	1,839,344	2.25	57.3
Upper Connellsville	21	[h] 2,819	[s] 60	514,186	330,886	576,860	1.74	64.4
Other districts [t]	21	[u] 2,216	[v] 330	1,094,451	830,044	2,449,874	2.95	75.8
Total	279	54,904	1,271	32,875,655	21,923,935	43,053,367	1.96	66.7

[a] Includes 372 United-Otto and 152 Newton-Chambers ovens.
[b] Includes 110 Semet-Solvay and 630 rectangular ovens.
[c] Includes 52 rectangular ovens.
[d] Rectangular ovens.
[e] Includes 1,237 rectangular ovens.
[f] Includes 400 rectangular ovens.
[g] Includes 332 United-Otto and 310 rectangular ovens.
[h] Includes 129 rectangular ovens.
[i] Rectangular ovens.
[j] Includes the Broadtop, Clearfield-Center, Irwin, and Lebanon and Schuylkill Valleys districts.
[k] Includes 232 United-Otto and 250 Semet-Solvay ovens.
[l] Didier ovens.
[m] Includes 110 Semet-Solvay and 711 rectangular ovens.
[n] Includes 100 Belgian ovens.
[o] Includes 1,724 rectangular ovens.
[p] Includes 204 rectangular ovens.
[q] Includes 10 rectangular, 332 United-Otto, 160 waste-heat, and 300 Belgian ovens.
[r] Includes 11 Ramsey ovens.
[s] Belgian ovens.
[t] Includes the Allegheny Valley, Broadtop, Clearfield-Center, Irwin, and Lebanon and Schulykill Valleys districts.
[u] Includes 250 Semet-Solvay and 228 United-Otto ovens.
[v] Includes 300 Didier ovens.

Connellsville district.—The Connellsville district of Pennsylvania is the largest coke-producing district in the world. The coal basin occupies a comparatively narrow synclinal trough, extending in a northeast-southwest direction nearly across the two counties of Fayette and Westmoreland and lying entirely within their boundaries. It is a short distance east of the city of Pittsburgh and supplies the larger part of the fuel consumed in the iron and steel furnaces of Pittsburgh and vicinity, the greatest iron-manufacturing center of the world. Large quantities of Connellsville coke are also shipped to distant points of consumption. This district, until 1903, produced from

40 to 50 per cent of the total coke output of the United States, the smaller percentage during the last few years being due to the largely increased production from the Lower Connellsville or Klondike region, which lies entirely within Fayette County and is separated from the Connellsville Basin proper by the Greensburg anticline. If to the Connellsville production is added that of the Lower Connellsville district, the supremacy of the region continues undisputed.

There were fewer ovens in existence in the Connellsville region at the close of 1911 than in any other year since 1906, the number of completed ovens having decreased from 24,481 in 1910 to 23,879 in 1911. The number of establishments abandoned and dismantled in 1911 was 6, reducing the number of coking plants from 118 to 112. There were 227 ovens, all of the beehive type, building at the close of the year. Of the 112 establishments in 1911, 19, with a total of 877 ovens, were out of blast throughout the year. Many of the other plants were shut down part of the year, and in a large number of instances portions of the plants only were kept in operation, the average number of such ovens idle through the year being 7,285. This made a total of 8,162 ovens out of blast in 1911. The 15,717 active ovens produced 9,565,013 short tons of coke, an average of 609 tons for each oven in operation. In 1910 the number of ovens in operation was 24,101 (222 more than all the ovens in existence at the end of 1911), and the production amounted to 11,459,601 tons of coke, an average of 475 tons for each active oven. The total production of the Connellsville district in 1911 was less than that of 1910 by 1,894,588 tons, or 16.5 per cent. The total value decreased from $23,121,556 to $18,471,506, a loss of $4,650,050, or 20 per cent. The average price for Connellsville coke declined from $2.02 in 1910 to $1.93 in 1911, the latter being the lowest point reached since 1904. The general average price for coke in Pennsylvania was $2.10 in 1910 and $1.96 in 1911. On the face it appears that the value of Connellsville coke, which is the standard blast-furnace fuel of the United States, was less than that made in other parts of the State. This apparent inconsistency is due largely to the fact that nearly all of the coke produced in the Connellsville district is the output of beehive ovens located in the immediate vicinity of the mines, whereas considerable quantities of coal are shipped from the mines of Pennsylvania to retort-oven plants at Johnstown, Glassport, Chester, and Lebanon, and the expense of transportation added to the cost of the coal naturally appears in a higher value for the coke at the ovens. In reaching markets from the Connellsville district the transportation expenses from the ovens to points of consumption must be borne by the coke.

Of the 23,879 ovens in the Connellsville district in 1911 only 110 are of the by-product recovery type. These are Semet-Solvay ovens operated by the Semet-Solvay Co. at Dunbar. A few rectangular (or Mitchell) ovens have been constructed in the district, but in these, as in the beehive ovens, the process is one of partial combustion and not of distillation. The average yield of Connellsville coal in coke in the Connellsville district is from 66 to 68 per cent; the yield of Connellsville coal in coke at retort-oven plants is from 75 to 80 per cent.

In the following table are presented the statistics of the manufacture of coke in the Connellsville district in 1880, 1890, 1900, and from 1907 to 1911:

Statistics of the manufacture of coke in the Connellsville region, Pennsylvania, 1880–1911

Year.	Establishments.	Ovens.		Coal used (short tons).	Coke produced (short tons).	Total value of coke at ovens.	Value of coke at ovens per ton.	Yield of coal in coke (per cent).
		Built.	Building.					
1880	67	7,211	731	3,367,856	2,205,946	$3,948,643	$1.79	65.5
1890	28	15,865	30	9,748,449	6,464,156	11,537,370	1.94	66.3
1900	98	20,981	686	14,946,659	10,020,907	22,383,432	2.23	67.0
1907	101	23,857	0	19,751,739	13,089,427	30,355,050	2.32	66.3
1908	104	24.071	118	10,238,665	6,880,951	14,025,422	2.04	67.2
1909	117	24,422	370	17,581,899	11,769,758	23,379,149	1.99	66.9
1910	118	24,481	206	17,205,615	11,459,601	23,121,556	2.02	66.6
1911	112	[a]23,879	227	14,420,328	9,565,013	18,471,506	1.93	66.3

[a] Includes 110 Semet-Solvay by-product ovens.

The following table, compiled by the Connellsville Courier, of Connellsville, Pa., shows the shipments of coke, by months, from the Connellsville and the Lower Connellsville districts. The figures are given in cars and tons with the average number of cars shipped each working day of the month, and include shipments from the Lower Connellsville district as well as from the Connellsville district proper. This authority gives the shipments in 1911 at 16,334,168 short tons, whereas the production for the Connellsville and the Lower Connellsville districts as reported to the Survey amounted to 16,919,749 tons. It is to be noted that only in November and December did the shipments in 1911 exceed those of 1910, the last two months of 1910 being the low ebb of the trade, which had been declining almost steadily from the high record for the region made in January of the same year. The average daily record of cars shipped in 1911 was 1,339, against 1,640 in 1910 and 1,920 in 1909. The largest number of cars shipped for any one month in the last three years was in January, 1910 (64,722 cars); the fewest number shipped was in January, 1911 (36,511 cars). The largest number of cars shipped in any one month in 1911, 49,581 cars in March, was more than 15,000 cars less than the maximum number of the preceding year.

The monthly shipments from this region in the years 1907 to 1911, as reported by the Courier, are given in the following table:

Monthly shipments of coke from the Connellsville and Lower Connellsville regions, 1907-1911, in short tons.

Month.	1907	1908	1909	1910	1911
January	1,698,475	742,096	1,205,650	1,952,406	1,194,04
February	1,625,783	810,436	1,143,487	1,787,164	1,302,09
March	1,701,342	841,059	1,185,814	1,922,575	1,621,30
April	1,708,590	772,915	1,144,751	1,754,654	1,419,36
May	1,787,611	759,813	1,235,044	1,527,515	1,343,87
June	1,677,488	772,367	1,429,289	1,544,964	1,299,29
July	1,741,612	856,843	1,605,937	1,446,294	1,257,82
August	1,787,190	952,492	1,641,287	1,464,060	1,355,77
September	1,650,207	975,606	1,704,919	1,390,140	1,394,75
October	1,805,307	1,030,552	1,821,444	1,450.717	1,424,23
November	1,167,796	995,807	1,835,745	1,252,797	1,385,62
December	677,657	1,190,036	1,832,465	1,196,436	1,335,97
Total	19,029,058	10,700.022	17,785,832	18,689,722	16,334,16

The total shipments, in cars, for the last 24 years were as follows:

Total and daily average shipments, in cars, 1888–1911.

Year.	Daily average.	Total cars.	Year.	Daily average.	Total cars.	Year.	Daily average.	Total cars.
1888	905	282,441	1896	920	289,137	1904	1,623	510,759
1889	1,046	326,220	1897	1,181	367,383	1905	1,886	688,328
1890	1,147	355,070	1898	1,415	441,249	1906	2,385	745,274
1891	884	274,000	1899	1,676	523,203	1907	2,210	691,757
1892	1,106	347,012	1900	1,619	504.410	1908	1,173	368,222
1893	874	270,930	1901	1,857	581,051	1909	1.920	600,979
1894	900	281,677	1902	1,986	624,198	1910	1,640	598,706
1895	1,410	441,243	1903	1,782	558,738	1911	1,339	448,672

Shipments of coke from the Connellsville region, including the Lower Connellsville district in 1910 and 1911, by months.

Month.	1910			1911		
	Cars.	Daily average.	Short tons.	Cars.	Daily average.	Short tons.
January	64,722	2,489	1,952,406	36,511	1,404	1,194,047
February	58,357	2,432	1,787,164	39,726	1,655	1,302,098
March	62,329	2,308	1,922,575	49,581	1,837	1,621,301
April	56,601	2,177	1,754,654	42,700	1,708	1,419,369
May	49,426	1,901	1,527,515	39,809	1,474	1,343,879
June	49,127	1,889	1,544.964	38,322	1,474	1,299,295
July	46,194	1,848	1,446,294	37,129	1,424	1,257,820
August	46,260	1,713	1,464,060	40,264	1,491	1,355,774
September	43,857	1,691	1,390.140	41,389	1,592	1,394,752
October	45,860	1.764	1.450.717	42,582	1,638	1,424,232
November	38,919	1,497	1,252,797	41,288	1,592	1,385,627
December	37,054	1,372	1,196,436	39,371	1,651	1,335,974
Total	598,706	1,640	18.689,722	488,672	1,339	16,334,168

As Connellsville coke is recognized as the standard for the United States and governs largely the prices for the product of other districts, the following table is given showing the prices for furnace and foundry coke, by months, during the years 1907 to 1911. These prices are quoted from The Iron Age and are for strict Connellsville coke. "Main line" and "outside" cokes are usually quoted from 15 to 20 cents below the strict Connellsville. Owing to the depressed condition of the iron trade which obtained through the entire year 1911, prices for Connellsville coke were the lowest in 10 years, falling from 50 cents to $1 less than in the boom year 1907, the average price being lower even than in the panic year 1908. The lowest prices in 1911 were always for "spot" coke—that is, coke sold for immediate delivery. In making contracts for future deliveries operators during the first six months of the year, hopeful of improved trade conditions, demanded from 30 to 45 cents more than spot values. In the last six months of the year the producers seemed to abandon hope of any marked improvement, and prices for contract coke were little, if any, higher than those obtained for immediate delivery. On account of the somewhat wide differences between the spot and the contract prices during the early months of the year, both sets of quotations, by months, are given for 1911 in the following table. The average price for all of the Connellsville coke sold in 1911 was $1.93.

Prices of Connellsville furnace and foundry coke, 1907–1911, by months.

Month.	Furnace.					
	1907	1908	1909	1910	1911	
					Spot.	Contract.
January	$3.50 to $3.75	$1.90 to $2.25	$1.50 to $2.00	$2.50 to $2.75	$1.40 to $1.55	$1.70 to $2.00
February	3.50 to 3.65	1.70 to 2.25	1.50 to 1.65	1.75 to 2.60	1.45 to 1.55	1.70 to 1.75
March	2.90 to 3.25	1.80 to 1.85	1.55 to 2.00	2.10 to 2.60	1.50 to 1.65	1.70 to 2.00
April	2.65 to 2.85	1.50 to 1.60	1.60 to 1.85	1.75 to 2.15	1.60 to 1.65	1.80 to 2.00
May	2.00 to 2.85	1.50 to 1.60	1.50 to 1.90	1.65 to 2.00	1.50 to 1.65	1.75 to 1.85
June	1.75 to 2.65	1.50 to 1.60	1.50 to 1.75	1.65 to 1.85	1.40 to 1.50	1.55 to 1.85
July	2.40 to 2.60	1.50 to 1.60	1.60 to 1.80	1.60 to 1.85	1.45 to 1.55	1.55 to 1.75
August	2.40 to 2.85	1.50 to 1.55	1.65 to 2.00	1.60 to 1.85	1.45 to 1.55	1.60 to 1.65
September	2.75 to 2.90	1.50 to 1.55	2.00 to 3.00	1.60 to 1.80	1.50 to 1.55	1.60 to 1.70
October	2.75 to 3.00	1.50 to 1.65	2.75 to 3.00	1.55 to 1.75	1.50 to 1.55	1.55 to 1.70
November	2.00 to 2.75	1.65 to 1.85	2.75 to 2.90	1.45 to 1.75	1.50 to 1.55	1.50 to 1.75
December	2.00 to 2.50	1.75 to 1.90	2.60 to 2.90	1.40 to 1.80	1.50 to 1.80	1.60 to 1.75

Month.	Foundry.					
	1907	1908	1909	1910	1911	
					Spot.	Contract.
January	$4.00 to $4.50	$2.00 to $2.65	$2.00 to $2.50	$2.85 to $3.25	$1.90 to $2.50	$2.25 to $2.50
February	3.75 to 4.50	2.40 to 2.75	1.85 to 2.25	2.50 to 3.00	2.10 to 2.50	2.25 to 2.50
March	3.50 to 4.00	2.10 to 2.40	1.85 to 2.25	2.60 to 3.15	2.00 to 2.50	2.25 to 2.40
April	3.25 to 3.75	1.85 to 2.25	1.75 to 2.40	2.50 to 3.00	2.00 to 2.00	2.25 to 2.40
May	2.75 to 3.25	2.00 to 2.25	1.80 to 2.35	2.15 to 2.75	1.75 to 2.00	2.10 to 2.40
June	3.00 to 3.25	2.00 to 2.25	1.80 to 2.50	2.15 to 2.50	1.75 to 2.00	2.00 to 2.40
July	3.00 to 3.25	2.00 to 2.25	1.80 to 2.50	2.15 to 2.50	1.85 to 2.00	2.10 to 2.40
August	3.00 to 3.75	1.90 to 2.25	1.70 to 2.50	2.15 to 2.50	1.95 to 2.00	2.00 to 2.50
September	3.15 to 3.50	1.90 to 2.00	2.25 to 3.25	2.10 to 2.50	1.85 to 2.00	2.10 to 2.40
October	3.25 to 3.40	2.00 to 2.25	2.75 to 3.50	2.15 to 2.50	1.85 to 2.00	2.10 to 2.40
November	2.50 to 3.00	2.15 to 2.25	3.00 to 3.50	2.00 to 2.50	1.85 to 2.00	2.10 to 2.40
December	2.50 to 2.75	2.15 to 2.25	3.25 to 3.50	1.90 to 2.50	1.90 to 2.00	2.10 to 2.25

Lower Connellsville district.—The first ovens in what is now known as the Lower Connellsville district were built in 1900, and although at the close of 1911 the district was only a little more than 11 years old, it is the second coke-making district in the United States and bids fair to rival the Connellsville district at no late date. The production of the Lower Connellsville district in 1900 was 385,909 short tons, in 1911 it was 7,354,736 tons, and in 1910, when the maximum record was made, the production was 8,219,492 tons. The production of coke in the Lower Connellsville district in 1910 was only 1,350,000 tons less than that of the Connellsville district in 1911 The production of the Connellsville district in 1911 was 16.5 per cen less than in 1910. The production in the Lower Connellsville dis trict decreased 864,756 tons, or 10.5 per cent. The relative gain o the Lower Connellsville district as a coke producer is shown by th fact that in 1909 its production was a little more than 50 per cent of th Connellsville district proper, and in 1911 it was nearly 80 per cent. Th production in the Lower Connellsville district in 1910 was more tha three and one-half times the entire product of West Virginia in 191 and nearly three times that of Alabama. The value of the cok produced in the Lower Connellsville region decreased from $16,048,67 in 1910 to $12,998,192 in 1911, a difference of $3,050,483, or 19.0 per cent. The average price per ton declined from $1.95 to $1.77

but what has been said in regard to the prices for Connellsville coke as compared with the general average for the State obtains also in regard to the product of the Lower Connellsville district.

There were 3 establishments with a total of 112 ovens abandoned in the Lower Connellsville district in 1911. One new establishment and 164 new ovens were added, so that there was a net decrease of 2, from 73 to 71, in the number of establishments, and a net gain of 52, from 14,805 to 14,857 in the number of ovens. Of the 71 establishments, 8 with a total of 507 ovens were not operated during 1911, and 2,317 ovens, portions of other plants, were also idle. The total number of idle ovens was, therefore, 2,824, leaving 12,033 as the number of ovens in active operation for all or a portion of the year. These 12,033 ovens produced an average of 611 tons of coke per oven. The rectangular (or Mitchell) ovens, to which reference has already been made, have found their greatest favor in the Lower Connellsville region, and of the 14,857 ovens in the district at the close of 1911, 1,724 were of the rectangular type. There were 654 new ovens in course of construction at the end of the year, of which 200 were rectangular. There were no by-product recovery ovens in the district.

The record of the district in 1900, 1905, and from 1907 to 1911, has been as follows:

Statistics of the manufacture of coke in the Lower Connellsville district, Pennsylvania, 1900, 1905, and 1907–1911.

Year.	Establishments.	Ovens.		Coal used (short tons).	Coke produced (short tons).	Total value of coke at ovens.	Value of coke at ovens per ton.	Yield of coal in coke (per cent).
		Built.	Building.					
1900	12	2,033	1,112	579,928	385,909	$792,886	$2.05	66.5
1905	45	7,484	1,145	5,666,812	3,871,310	7,532,382	1.95	68.3
1907	62	12,264	1,068	9,150,693	6,310,900	15,758,049	2.50	69.0
1908	62	13,162	1,203	6,156,553	4,252,222	7,796,860	1.83	69.1
1909	70	14,215	1,036	9,781,803	6,761,335	12,490,518	1.85	69.1
1910	73	14,805	[b] 668	12,130,425	8,219,492	16,048,675	1.95	67.8
1911	71	[a] 14,857	[b] 654	10,771,495	7,354,736	12,998,192	1.77	68.3

[a] Includes 1,724 rectangular ovens.

[b] Includes 200 rectangular ovens.

TENNESSEE.

The eastern part of Tennessee is crossed, in a northeast-southwest direction, by the coal measures of the Appalachian province. Coal is mined in 17 counties and coke is made in 8. The counties in which coke is made are Campbell, Grundy, Hamilton, Marion, Morgan, Rhea, Roane, and Sequatchie. The larger part of the workable coal in the State occurs in three basins, the Wartburg, the Walden, and the Sewanee. (See report on production of coal, 1910.) Each of these basins contains a number of workable coal beds, as many as seven having been noted in the Walden Basin. Nearly all of the Tennessee coals possess coking qualities, but not all to the same degree, as is attested by the number of idle ovens during the last four years. In 1910 there were 16 establishments in the State, of which 7 were idle, and in 1911, out of 15 establishments (one having been abandoned during the year) 8 were idle. The 8 idle establishments in 1911 represented 1,196 ovens, nearly 50 per cent of the total number of ovens in the State. The total number of ovens idle during the year, the idle ovens of other establishments being added to the idle plants, was 1,565, or 60 per cent of the total number. One establishment of 175 ovens was abandoned, and 84 other ovens, portions of plants, were dismantled; 14 new ovens were constructed, making a net decrease of 245 in the number of ovens in the State in 1911, as compared with 1910.

The production of coke in Tennessee in 1911 amounted to 330,418 short tons, valued at $797,758, against 322,756 short tons, valued at $959,104, in 1910, the depression in the iron industry in Tennessee being exhibited in the coke production by the marked falling off in value, notwithstanding the increase in production. The output in 1911 was 7,662 short tons more than in 1910, but there was a decrease of $161,346 in the value of the output. The average price per ton declined from $2.97 in 1910 to $2.41 in 1911, the latter being the lowest price since 1904. All the ovens in Tennessee are of the ordinary beehive type.

The quantity of coal used in the manufacture of coke in Tennessee in 1911 was 628,118 short tons, all of which was washed before being charged into the ovens. The coal used for coke making consisted of 283,203 tons of washed run of mine and 344,915 tons of washed slack.

The statistics of the manufacture of coke in Tennessee in the years 1880, 1890, 1900, and from 1907 to 1911 are shown in the following table:

Statistics of the manufacture of coke in Tennessee, 1880–1911.

Year.	Establishments.	Ovens.		Coal used (short tons).	Coke produced (short tons).	Total value of coke at ovens.	Value of coke at ovens per ton.	Yield of coal in coke (pe cent).
		Built.	Building.					
1880	6	656	68	217,656	130,609	$316,607	$2.42	60.
1890	11	1,664	292	600,387	348,728	684,116	1.96	58.
1900	14	2,107	340	854,789	475,432	1,269,555	2.67	55.
1907	18	2,806	80	825,221	467,499	1,592,225	3.41	56.
1908	17	2,792	20	395,936	214,528	561,789	2.62	54.
1909	16	2,792	0	493,283	261,808	667,723	2.55	53.
1910	16	2,792	0	597,658	322,756	959,104	2.97	54.
1911	15	2,547	30	628,118	330,418	797,758	2.41	52.

The character of the coal used in the manufacture of coke in Ter nessee in 1890, 1900, and since 1907, is shown in the following tabl

Character of coal used in the manufacture of coke in Tennessee, 1890, 1900, and 1907–191 in short tons.

Year.	Run of mine.		Slack.		Total.
	Unwashed.	Washed.	Unwashed.	Washed.	
1890	255,359	0	273,028	72,000	600,
1900	150,697	349,448	24,122	330,522	854,
1907	54,397	386,094	0	384,730	825,
1908	29,668	250,120	102,578	13,570	395,
1909	30,361	285,591	0	177,331	493,
1910	41,650	346,769	0	209,239	597,
1911	0	283,203	0	344,915	628,

UTAH.

As there is but one company in Utah engaged in the manufacture of coke, the statistics of production have been included with those of Colorado, which adjoins Utah on the east. The coals of Utah used in the manufacture of coke are practically identical in character with those of western Colorado.

VIRGINIA.

All of the coking coals of Virginia are contained in a few counties lying in the extreme southwestern portion of the State and within the coal fields of the Appalachian province. The development of this region began in 1883 with the completion of the New River division of the Norfolk & Western Railway, and for 10 years the manufacture of coke, as well as the production of coal in Virginia, was almost entirely from Tazewell County. Ten years from the opening of the district, or in 1893, the Norfolk & Western Railway completed a branch up the Clinch Valley and opened what is now the most important coking-coal district in Wise County. During 1906 and 1907 extensive developments in what is known as the Black Mountain field in Lee County followed the construction into that district of the Black Mountain Railroad, now operated jointly by the Southern Railway and the Louisville & Nashville Railroad.

Like West Virginia, Virginia suffers in its manufacture of coke from the handicap of having no local markets for its product, except the furnaces at Low Moor and Covington, where the coke ovens were operated in connection with the furnaces and on coal drawn from the New River district of West Virginia. Consequently, in the years of depression in the iron trade, as in 1911, the production of coke in Virginia as in West Virginia exhibits a considerably larger decrease than that shown in some of the other coke-producing States. In Virginia the production decreased from 1,493,655 short tons valued at $2,731,348 in 1910, to 910,411 tons valued at $1,615,609 in 1911, the decrease being 583,244 short tons, or 39.5 per cent in quantity, and $1,115,739, or 40.8 per cent in value. The average price per ton declined from $1.83 in 1910 to $1.77 in 1911.

There were 18 coke-making establishments in Virginia at the close of 1911, the same number as in 1910. The number of completed ovens was increased 107, from 5,389 to 5,496. There were 4 entire plants and 3,223 ovens idle during the year. All of the ovens in operation during the year were of the beehive type. There are no by-product recovery ovens in the State.

The coke manufactured in Wise County, on the Clinch Valley branch of the Norfolk & Western Railway, and in the Black Mountain district in Lee County is the only coke made in Virginia from coal mines exclusively within the State. There are two plants in Virginia, one at Lowmoor and one at Covington, the coal for both of which is drawn from the mines in the New River district of West Virginia. The coal for the ovens at Pocahontas in Tazewell County is obtained from mines whose workings extend across the State boundary line into West Virginia and a part of this coal production should properly be credited to West Virginia. The openings of the mines, however, and the coke ovens, are in Tazewell County, and it is customary to credit the coal, as well as the coke, to Virginia.

The statistics of the manufacture of coke in Virginia in 1883, when the first operations were begun, and in 1890, 1900, and from 1907 to 1911, inclusive, are shown in the following table:

Statistics of the manufacture of coke in Virginia, 1883–1911.

Year.	Establishments.	Ovens.		Coal used (short tons).	Coke produced (short tons).	Total value of coke at ovens.	Value of coke at ovens per ton.	Yield of coal in coke (per cent).
		Built.	Building.					
1883	1	200	0	39,000	25,340	$44,345	$1.75	65.0
1890	2	550	250	251,683	165,847	278,724	1.68	66.0
1900	7	2,331	300	1,083,827	685,156	1,464,556	2.14	63.2
1907	19	5,333	50	2,264,720	1,545,280	3,765,733	2.44	68.2
1908	19	4,853	158	1,785,281	1,162,051	2,121,980	1.83	65.1
1909	19	5,469	100	2,060,518	1,347,478	2,415,769	1.79	65.1
1910	18	5,389	100	2,310,742	1,493,655	2,731,348	1.83	64.6
1911	18	[a] 5,496	100	1,425,303	910,411	1,615,609	1.77	63.9

[a] Includes 56 Newton-Chambers ovens.

On account of the depression in the iron trade, and the diminished demand for coke, in 1911, most of the coal used for coke making in that year was slack coal, although usually about 70 per cent of the coal used in the coke ovens of Virginia is run of mine. In 1911, fo the first time in five years, the quantity of slack used exceeded the quantity of mine run, the quantities being, respectively, 749,806 and 675,497 short tons. All of it was used unwashed.

The following table shows the character of the coal used in cok making in Virginia in 1890, 1900, and from 1907 to 1911:

Character of coal used in the manufacture of coke in Virginia, 1890–1911, in short tons

Year.	Run of mine.		Slack.		Total.
	Unwashed.	Washed.	Unwashed.	Washed.	
1890	98,215	0	153,468	0	251,68
1900	620,207	0	463,620	0	1,083,82
1907	1,271,518	0	993,202	0	2,264,72
1908	1,438,754	0	346,527	0	1,785,28
1909	1,405,111	0	655,407	0	2,060,51
1910	1,554,784	0	755,958	0	2,310,74
1911	675,497	0	749,806	0	1,425,30

WASHINGTON.

Washington is the only State west of the Rocky Mountains tha contains coal possessing coking qualities, and the coking industry Washington is restricted to a limited area in Pierce County. Test made at the experimental plant of the United States Geological Surve at Denver in 1908 showed that a fair quality of coke could be mad from the coal mined in the northern part of the Roslyn field i Kittitas County (the only workable coal in Washington east of th Cascades), but so far no attempt has been made to coke this coal on commercial scale. There were 6 establishments in the State in 191 one of which having 50 ovens was dismantled, reducing the numb of establishments to 5, and the total number of ovens from 285 to 23

Three plants with a total of 75 ovens were idle. The coking operations in 1911 were confined to two plants in the Wilkeson-Carbonado field in Pierce County. The production in the State decreased from 59,337 tons, valued at $347,540, in 1910, to 40,180 tons, valued at $216,262, in 1911. The smelter at Tacoma consumes the greater part of the product. All of the coal used in Washington for coke making is washed before being charged into the ovens. Of the total quantity coked in 1911, 20,154 short tons were run of mine and 40,047 tons slack.

The coke industry of Washington began in 1884, when 400 tons of coke were made in pits. The first ovens were built in 1885. The statistics of production in 1884, 1890, 1900, and from 1907 to 1911 are as follows:

Statistics of the manufacture of coke in Washington, 1884–1911.

Year.	Establishments.	Ovens.		Coal used (short tons).	Coke produced (short tons).	Total value of coke at ovens.	Value of coke at ovens per ton.	Yield of coal in coke (per cent).
		Built.	Building.					
1884	1	0	0	700	400	$1,900	$4.75	57.0
1890	2	30	80	9,120	5,837	46,696	8.00	64.0
1900	2	90	0	54,310	33,387	160,165	4.80	61.5
1907	5	216	0	85,860	52,028	293,019	5.63	60.6
1908	6	231	50	68,069	38,889	213,138	5.48	57.1
1909	6	285	0	69,708	42,981	240,604	5.60	61.7
1910	6	285	0	94,223	59,337	347,540	5.86	63.0
1911	5	235	0	60,201	40,180	216,262	5.38	66.6

WEST VIRGINIA.

For six years, from 1905 to 1910, inclusive, West Virginia stood next to Pennsylvania and consequently second in importance as a coke-producing State. Previous to 1905 Alabama and West Virginia had been for more than two decades close rivals for the honor, frequently alternating. Since 1904, and until a reversal came, West Virginia had apparently become firmly established as second in rank, so far as the quantity of output is concerned, though Alabama steadily outclassed her rival in the value of the product. On account of Alabama's exceptional resources in iron ore, fuel, and fluxing material, and the ability to make cheap iron, that State in years of depression in the iron trade, like 1911, assumes relatively a more important position in the manufacture of iron and of coke than in years of activity and high prices. West Virginia, on the other hand, with no local markets for her coke, shows greater proportionate gains in fat years in the iron trade and greater losses in lean years. The year 1911 was essentially lean and the production of coke in West Virginia showed the largest percentage of decrease in any State in the Union. The quantity of coke made in West Virginia decreased from 3,803,850 short tons, valued at $7,354,039, in 1910 to 2,291,049 short tons, valued at $4,236,845, in 1911, a loss of 1,512,801 short tons, or 39.8 per cent, in quantity and of $3,117,194, or 42.4 per cent, in value. Alabama's production decreased 487,506 short tons, or 15 per cent, from 3,249,027 tons in 1910 to 2,761,521 tons in 1911, the output in the latter year exceeding that of West Virginia by 470,472 tons, or 20.5 per cent. The advantage possessed by Alabama in having the coal consumptive markets of the iron-manufacturing center—Birmingham and vicinity—is exhibited even more strikingly in the value of the coke product, for in all the years that West Virginia exceeded Alabama in the quantity of production, Alabama led in value, and in 1911 the value of Alabama's coke, though inferior in quality to that of West Virginia, exceeded the value of West Virginia's production by $3,356,749, or about 80 per cent. The average price of West Virginia coke in 1911 was $1.85 per short ton; that of Alabama was $2.75.

Next to Pennsylvania, West Virginia possesses more wealth in supplies of coking and other high-grade coals than any other State in the Union, but as long as both the coal and the coke continue to be shipped out of the State, West Virginia will not attain the position she should occupy as a manufacturing State, nor will the miners of coal and makers of coke receive a just return for these products. At the present time, ranking second as a producer of coal and third in the production of coke, West Virginia stands thirty-fourth in the value of her manufactured products. The principal beneficiaries of the coal-mining and coke-making industries in the State are the transportation companies.

The number of coking establishments in West Virginia in 1911 was 138, an increase of 3 over 1910. Of the 138 establishments, 55 were not in operation. The idle establishments represented a total of 4,334 ovens and there were in addition to that number 7,430 ovens out of blast at plants that were in partial operation. The total of 11,764 idle ovens exceeded the number of active ovens by 3,652. There were two plants of 50 ovens each abandoned in 1911, and 185 ovens, portions of other establishments, were torn down. The total number of ovens in the State decreased from 19,912 in 1910 to 19,876 in 1911. All of the ovens in the State, with the exception of 120 Semet-Solvay by-product ovens at Benwood, near Wheeling, are of the beehive type. Only 8,112 ovens were in operation during 1911, and the average output per oven was 282 tons. More than half of the idle ovens in 1911 were in the Pocahontas-Flat Top district, there being only four of the operating companies in that district that did not report a considerable percentage of their ovens out of blast.

In the following table will be found the statistics of the manufacture of coke in West Virginia in 1880, 1890, 1900, and for the last five years:

Statistics of the manufacture of coke in West Virginia, 1880–1911.

Year.	Establishments.	Ovens.		Coal used (short tons).	Coke produced (short tons).	Total value of coke at ovens.	Value of coke at ovens per ton.	Yield of coal in coke (per cent).
		Built.	Building.					
1880	18	631	40	230,758	138,755	$318,797	$2.30	60.0
1890	55	4,060	334	1,395,266	833,377	1,524,746	1.83	60.0
1900	106	10,249	1,306	3,868,840	2,358,499	4,746,633	2.01	60.9
1907	142	19,688	459	6,536,795	4,112,896	9,717,130	2.36	62.9
1908	138	20,124	0	4,127,730	2,637,123	5,267,054	2.00	63.9
1909	138	20,283	126	6,361,759	3,943,948	7,525,922	1.91	62.0
1910	135	19,912	230	6,226,234	3,803,850	7,354,039	1.93	61.1
1911	138	[a]19,876	130	3,754,561	2,291,049	4,236,845	1.85	60.4

[a] Includes 120 Semet-Solvay ovens at Benwood.

Most of the coke ovens in West Virginia were built for the purpose of utilizing the slack coal from the coal-mining operations. In years of depression like 1911 the proportion of slack coal used increases materially, whereas in years of brisk demand larger quantities of mine-run coal are required to charge the ovens. Ordinarily the coal used in the West Virginia ovens is about 40 per cent mine run and 60 per cent slack. In 1911 the proportion of slack used increased to 70 per cent, and that of mine run decreased to 30 per cent. Only a little more than 10 per cent of all the coal used for coke making in West Virginia is washed before being charged into the ovens, as in most of the coke-making districts the raw product is a low-ash, high-carbon coal, comparatively free from sulphur. In some districts it is found that crushing the mine-run coal before coking produces a more satisfactory coke.

The character of the coal used in the manufacture of coke in West Virginia in 1890, 1900, and from 1907 to 1911, is shown in the following table:

Character of coal used in the manufacture of coke in West Virginia, 1890–1911, in short tons.

Year.	Run of mine.		Slack.		Total.
	Unwashed.	Washed.	Unwashed.	Washed.	
1890	324,847	0	930,989	139,430	1,395,266
1900	509,960	8,000	3,140,064	210,816	3,868,840
1907	2,451,811	27,067	3,874,817	183,100	6,536,795
1908	1,694,470	35,226	2,206,623	191,411	4,127,730
1909	2,282,403	32,285	3,644,271	402,800	6,361,759
1910	2,088,553	234,484	3,462,927	440,270	6,226,234
1911	925,460	158,308	2,408,299	262,494	3,754,561

PRODUCTION BY DISTRICTS.

It has been customary in the preceding reports of this series to consider the coke production by the districts into which the State has been divided. These districts are known, respectively, as the Upper Monongahela, the Upper Potomac, the Kanawha, the New River, and the Flat Top. The first two are in the northern part of the State and are named from the rivers, the Monongahela and the Potomac, by whose headwaters they are drained. The other three districts are in the southern part of the State. The New River district includes the ovens along the line of the Chesapeake & Ohio Railway and its branches from Quinnimont to Hawks Nest, near which point the coals of the New River region go below water level. The Kanawha district embraces all of the ovens along Kanawha River and its tributaries from Mount Carbon to the western limit of the coal fields. The ovens of the Gauley Mountain Coal Co. at Ansted are included in the New River district, although the Ansted coal belongs in reality to the coal series of the Kanawha district and lies about 1,000 feet above the New River coals. The Flat Top region is drained by the upper portions of New, Guyandotte, and Big Sandy rivers, and includes the ovens in West Virginia, which belong to the Pocahontas coal field. The Flat Top district is by far the most important and bears the same relation to the production of West Virginia that the Connellsville district bears to that of Pennsylvania. Since 1900 the statistics of production of the Flat Top district have included the new operations along Tug River lying west of and continuous with the Flat Top district. The output from the Flat Top-Tug River district averages somewhat more than 50 per cent of the total coke production of the State.

The statistics of the production of coke in West Virginia by districts in 1909 and 1910 are shown in the following tables:

Production of coke in West Virginia in 1910 and 1911, by districts.

1910.

District.	Establishments.	Ovens.		Coal used (short tons).	Coke produced (short tons).	Total value of coke at ovens.	Value of coke at ovens per ton.	Yield of coal in coke (per cent).
		Built.	Building.					
Flat Top[a]	53	11,866	0	3,641,948	2,203,793	$4,138,870	$1.88	60.5
Kanawha	11	1,697	0	625,164	378,921	790,810	2.09	60.6
New River	23	1,781	0	532,276	328,267	705,388	2.15	61.7
Upper Monongahela	36	[b] 3,068	150	893,882	551,854	1,062,438	1.93	61.7
Upper Potomac and Tygarts Valley	12	1,500	80	532,964	341,015	656,533	1.93	64.0
Total	135	19,912	230	6,226,234	3,803,850	7,354,039	1.93	61.1

1911.

District.	Establishments.	Ovens.		Coal used (short tons).	Coke produced (short tons).	Total value of coke at ovens.	Value of coke at ovens per ton.	Yield of coal in coke (per cent).
		Built.	Building.					
Flat Top[a]	54	11,830	0	2,069,509	1,193,860	$2,082,945	$1.74	57.7
Kanawha	11	1,727	0	411,456	252,269	443,240	1.76	61.3
New River	23	1,787	0	254,943	162,349	352,714	2.17	63.7
Upper Monongahela	37	[b] 3,008	50	772,450	514,847	1,087,652	2.11	66.7
Upper Potomac and Tygarts Valley	13	1,524	80	246,203	167,724	270,294	1.61	68.1
Total	138	19,876	130	3,754,561	2,291,049	4,236,845	1.85	60.4

[a] Includes Tug River district.

[b] Includes 120 Semet-Solvay ovens.

OTHER STATES.

In the following table are presented the statistics of coke production in those States in which there are less than three establishments in operation. Eleven States are included in this table in 1911, the same number as in 1910, but two changes have been made, the table as printed below including the production of Illinois and not of New York, whereas in the report for 1910 New York was included and Illinois was not. The reason for these changes is that in 1911 there were only two establishments operating in Illinois and the production is combined with other States in order not to divulge confidential returns. New York has had more than two establishments for several years and the comparisons for 1910 and 1911 are given separately in the preceding pages. The 10 States, in addition to Illinois, included in the following table are: Indiana, Kansas, Maryland, Massachusetts, Michigan, Minnesota, Montana, New Jersey, Oklahoma, and Wisconsin. Montana and Oklahoma made no coke in 1911. In the 11 States comprised in this table there were 29 establishments in 191 and 27 in 1911. Of the 27 establishments in 1911, 14, with a tota of 985 ovens, were idle and 23 other ovens were out of blast. Th net increase in the total number of ovens was 478, there being 49 new ovens built (490 of these being Koppers ovens at Gary, Ind.

and 16 ovens (2 in Illinois and 14 in Kansas) being dismantled. Of the 3,356 ovens included in the table, 2,142, or more than 63 per cent, were of the by-product recovery type. This fact accounts for the high average yield of coal in coke (75.1 per cent in 1910 and 76.1 per cent in 1911), and, because of their locations at distances from the coal mines and the added cost of transportation, also for the higher value of the coke. Of 143 ovens building at the close of the year, all but 25 were by-product ovens.

The combined production of the 11 States in 1911 was 4,633,819 short tons, valued at $17,379,795, against 3,684,276 tons, valued at $14,509,072, in 1910.

Six of the 11 States included in this statement—Maryland, Michigan, Minnesota, New Jersey, New York (prior to 1910), and Wisconsin—obtain the coal for coke making from the mines of other States, and Massachusetts obtains its supply of coal from Nova Scotia and West Virginia. All of the ovens in these States, with the exception of 1 plant of 228 beehive ovens in Wisconsin, are by-product recovery ovens.

The statistics of production in the States having less than three establishments each since 1900 are shown in the following table:

Statistics of coke production from 1900 to 1911 in States having only one or two establishments.

Year.	Establishments.	Ovens.		Coal used (short tons).	Coke produced (short tons).	Total value of coke at ovens.	Value of coke at ovens per ton.	Yield of coal in coke (per cent).
		Built.	Building.					
1900	10	832	594	708,295	506,730	$1,454,029	$2.87	71.5
1901	11	862	609	793,187	564,191	1,607,476	2.85	71.0
1902	11	898	742	852,977	598,869	2,063,894	3.45	70.2
1903	17	1,308	760	1,306,707	932,428	3,228,064	3.46	71.3
1904	14	1,753	658	2,046,340	1,469,845	4,830,621	3.29	71.8
1905	12	1,666	145	2,222,723	1,660,857	5,500,337	3.31	74.7
1906	12	1,952	0	2,861,934	2,085,617	7,474,889	3.58	72.9
1907	11	1,878	0	3,415,723	2,528,739	10,302,269	4.07	74.0
1908	30	3,456	103	3,155,100	2,286,092	8,338,363	3.65	72.5
1909	20	2,553	563	3,427,732	2,509,306	9,129,282	3.64	73.3
1910	29	2,878	563	4,903,129	3,684,276	14,509,072	3.94	75.1
1911	27	[a] 3,356	[b] 143	6,089,917	4,633,819	17,379,795	3.75	76.1

[a] Includes 492 Semet-Solvay, 770 Koppers, 24 Belgian, 880 United Otto ovens.

[b] Includes 105 Koppers and 13 Semet-Solvay ovens.

FUEL BRIQUETTING.

By Edward W. Parker.

INTRODUCTION.

Some progress has been made in the development of fuel briquetting in the United States during the last two years, or since 1909, when the latest previous report on this subject was published by the United States Geological Survey, but this country still lags far behind some of the European countries, particularly Germany. In 1909 the production of fuel briquets in the United States was 139,661 short tons, valued at $452,697, which was an increase of nearly 55 per cent in quantity and of about 40 per cent in value over 1908. In 1911 the production amounted to 218,443 short tons, valued at $808,721, the increase in two years amounting to 78,782 short tons, or 56.41 per cent, in quantity, and to $356,024, or 78.65 per cent in value.

The comparison of the production of this artificial fuel in the United States with that of Germany shows the insignificance of the industry in this country. But the subject is one to which attention should be given, as on it depends to a considerable degree the utilization of some grades of fuel which should be made useful but which are now wasted or sold at less than the actual cost of production. The reprehensible but apparently growing practice of shooting bituminous coal "off the solid" (and this is notably prevalent in the noncoking coal fields of the Mississippi Valley) produces an inordinate proportion of slack, an undesirable product which it is difficult or impossible to sell, and, in fact, by the best mining practice the quantity of slack produced is frequently too large to be profitably disposed of. Some of it, quite significant quantities indeed, are used as powdered fuel in the manufacture of cement; but its use under boilers is unsatisfactory, as in the high heat of combustion the ash is fused and is deposited as a glassy material on the boiler tubes, and thus eventually produces an insulating covering which destroys the efficiency of the plant. The principal factor militating against the more rapid development of fuel briquetting in the noncoking coal fields of the Middle West is the low price of the raw fuel with which the manufactured product has to compete, and as long as new areas can be opened without restriction, and the supply of cheap coal continued, so long will the present profligacy be maintained and the slack continue to be unused except to a limited degree.

The average price for coal in the Middle States in 1911 ranged from $1.08 in Indiana to $2.03 in Oklahoma. The cost of manufacturing briquets, exclusive of the cost of the raw material, is about $1 per ton, and although briquets possess undoubted advantage for domestic use over raw coal, particularly if the latter is unsized, householders have to be educated to the fact, and when such educational efforts are handicapped by the higher cost of the new fuel, more efficient and more economical though it be, the task of demonstrating the fact is attended with some difficulty. In Germany where the price of coal is relatively high and the cost of labor relatively low, the briquetting industry has made extraordinary progress. In 1910 the production of briquets in Germany was 19,567,016 metric tons (21,568,722 short tons), and in 1911 it amounted to 21,827,667 metric tons (24,060,637 short tons). Compared with these figures the production of 218,443 short tons of briquets in the United States falls into insignificance. Some probability of more substantial development of briquetting in the Eastern States is evinced by the advance of 25 cents a ton on the domestic sizes of anthracite in the spring of the present year, which followed the advance of 10 per cent in wages agreed upon as the result of the strike in the anthracite region on April 1. There is little possibility of any future reduction in the price of this fuel. In fact, further advances are rather to be expected, for it is rumored that one of the large owners of coal lands in the anthracite region will, upon the expiration of present contracts, exact an advance of 25 cents in the royalty to be paid. Other owners of the land will probably follow suit, and the public will be called upon to foot the bills. It seems reasonable, therefore, to suggest that the utilization of the small sizes by manufacturing them into briquets for domestic use on which a profit could be obtained might be more rational than selling them, as is now done, below the cost of production, because as a steam-raising fuel they must be sold in competition with bituminous coal. The quantity of this grade of raw material for briquetting is enormous. In 1911 the shipments of anthracite below pea coal in size amounted to over 20,000,000 long tons, of which 85 per cent was from the preparation of freshly mined coal. The culm banks which still remain in the anthracite region, unsightly monuments to the not inexcusable but wasteful mining methods practiced in the earlier history of the region, contain millions of tons of usable small coal, and from 3,000,000 to 4,000,000 tons of this fuel are being recovered annually by washeries, the product yielding a return which amounts practically to a reduction, simply, in the average cost of production. The 20,000,000 tons of small sizes marketed in 1911 were worth not to exceed $30,000,000. If manufactured into briquets of egg and stove size this tonnage would have been worth $70,000,000. The cost of briquetting, most of which would have been expended in the employment of labor, would have been about $25,000,000. In other words, the outlay of $25,000,000 would have brought a return of 60 per cent in profit. These are, of course, mere estimates, purely hypothetical. It is not claimed that the results would be actually obtained in commercial practice, but that they are possible, all conditions being favorable, is evident.

In the report for 1909 it was suggested that greater inducement to the investment of capital in briquetting could be offered if investors were assured of a regular supply of binder at reasonably steady prices. The concomitant industry from which this binder may be secured, the manufacture of coke in by-products ovens, has shown notable progress in the last two or three years, and as experience continues to prove the eventual economy of this method as compared with the wasteful beehive practice, the retort oven is destined to supplant the beehive, and as this evolution progresses the supply of coal-tar pitch at reasonably low cost should be assured. In 1911 when the total production of coke in the United States showed a material decrease (about 15 per cent), the number of retort ovens in use increased from 4,078 to 4,624, and the output of by-product coke increased 10 per cent.

In addition to the slack from bituminous (and in this should be included subbituminous and semianthracite) noncoking coal and small sizes of anthracite, three other sources of raw material for briquetted fuel are available, namely, lignite, peat, and breeze from gas coke. European practice has shown that the briquetting of lignite and peat can be better and more economically accomplished without the use of a binder. The supplies of lignite available in North Dakota and Texas are practically limitless. The peat occurrences are chiefly in the drainage areas of the Great Lakes and the Atlantic seaboard. They are generally somewhat remote from the coal fields and the product when properly prepared makes an excellent substitute for the more expensive coal. The utilization of coke breeze presents a problem distinctly its own—the destructive abrasive action on the crushing apparatus, the bearings of the machinery, and the briquetting molds. It has been truly said that coke dust "cuts like a diamond," and the repair and replacement of the parts of the machinery affected by it make expensive items in the attempts that have been made to use coke breeze in the manufacture of briquets. The quantity of breeze produced each year in the manufacture of gas coke amounts to between 2,000,000 and 3,000,000 tons.

The Los Angeles Gas & Electric Corporation, of Los Angeles, Cal., operates a briquetting plant for utilizing the carbon obtained as a by-product in the manufacture of illuminating gas from crude petroleum. The briquets, or "boulets," make excellent domestic fuel.

The writer has in previous reports hazarded and still maintains the opinion that careful investors have been kept back from ventures in briquetting enterprises by attempts that have been and continue to be made to exploit secret binders and processes for which extraordinary merits are claimed but which have not proved successful in commercial operations. The pathway of briquetting development is strewn with wrecks due to this cause. As stated in the report for 1909, there is absolutely no reason for secrecy as to the constituents of patented binders. The field to be developed is so large that there is room for everyone, provided the expense is not inhibitive and the resultant briquet is a satisfactory fuel. The better educated the public becomes in the use of briquetted fuel the more rapidly will the industry develop, the most pronounced retarding element being the tendency to exploit secret methods of questionable merit instead of progressing along conservative lines laid down by the experience of European countries.

There were 21 plants in the United States which manufactured compressed fuel in 1911, an increase of 5 over 1909. Four of the 21 plants in 1911 were operated only for experimental or for demonstrative purposes. Of those that were operated as commercial plants, 8 used anthracite as a raw material, 2 used bituminous coal, 2 used semianthracite, 1 used refuse from oil-gas works, 1 used peat, and 3 used mixed material. The various manufacturers place their products on the market under special names, such as "boulets," "eggettes," "carbonets," "coalettes," and "patent fuel," but all are included in this report under the general term "briquets."

In order to meet with popular favor in this country briquets must be of a convenient shape for shoveling and for the circulation of air in the fire box. They must be of suitable size for the purposes they are intended to serve, and must possess sufficient cohesion to resist fracture and abrasion under rough handling. The very large briquets made in European countries, particularly in Germany, the chief reason for which is the advantage for stowage in bunkers of steamships and tenders of locomotives, are not adapted for use in this country. They must be handled and stowed by hand, and must be broken up before being shoveled into the fire. Labor conditions in this country make the cost of such handling prohibitive.

PRODUCTION.

The production of briquets in the United States in 1907, 1908, 1909, and 1911, has been as follows:

Production of briquets in the United States in 1907, 1908, 1909, and 1911, in short tons.

Year.	Quantity.	Value.
1907	66,524	$258,426
1908	90,358	323,057
1909	139,661	452,697
1911	218,443	808,721

The production of briquets in 1911, by States, so far as the individual State distribution can be shown, is given in the table below. Where several States are combined, they are grouped (as closely as possible) according to geographic proximity.

Production of briquets in the United States in 1911, by States, in short tons.

State.	Quantity.	Value.
Maryland New Jersey Rhode Island	44,724	$146,245
New York	22,350	123,925
Pennsylvania	91,426	223,613
Illinois Indiana Iowa	7,193	30,439
California Michigan Missouri Washington Wisconsin	49,750	284,499
Total	218,443	808,72

BINDERS.

Experience in European countries and the investigations which have been carried on in the fuel-testing plant of the United States Geological Survey at St. Louis and later by the United States Bureau of Mines at Pittsburgh have demonstrated clearly that the successful briquetting of lignite may be accomplished without the use of any additional binding material, and that for the anthracite, semi anthracite, bituminous, and subbituminous coals the most satisfactory binders are coal-tar pitch, gas-tar pitch, and asphaltic pitch, or inexpensive mixtures of which one or more of these are the principal constituents. The plants in successful operation in this country at the present time have added their experience to the evidence on this point. One plant began operating in 1910, using a binder of which oil obtained from the distillation of wood is one of the constituents, with apparently satisfactory results. Inorganic binders, though efficient in cementing quality, have the serious objection of increasing the ash and of adding nothing to the combustible character of the fuel. Pitch binders, on the other hand, contribute combustible material and do not increase the ash.

BRIQUETTING PLANTS IN THE UNITED STATES IN 1911.

In the following paragraphs brief statements regarding the briquetting plants that were in operation in the United States during 1911 are given. Most of the plants have been described in previous reports of the United States Geological Survey or in the technical press. Where such descriptions have been given references are noted.

Los Angeles Gas & Electric Co., Los Angeles, Cal.—This plant has been in operation since December, 1905. It was constructed for the purpose of utilizing the carbon obtained as a by-product in the manufacture of illuminating gas from petroleum. This material, water free, contains about 88 per cent of carbon, 11 per cent of volatile combustible matter, principally tar, 0.5 per cent of sulphur, and 0.5 per cent of ash. No binder is used, the natural tar present being sufficient for the cementing of the briquets. The annual output of the plant is approximately 10,000 short tons of briquets.

Western Fuel Co., Oakland, Cal.—The plant of this company was constructed for the purpose of utilizing screenings from the company's coal yards, using asphaltic pitch as a binder. The plant is described in United States Geological Survey Bulletin 316. It has a capacity of 60 tons a day of 10 hours. The briquetting mixture consists of 92 per cent of coal-yard screenings to 8 per cent of binder. The operation of the plant is dependent upon the quantity of screenings available, as well as upon the rather uncertain domestic requirements of Oakland.

New Staunton Coal Co., Livingston, Ill.—This plant, which is described in the report on coal briquetting in 1909, is used at present only for demonstrating briquetting machinery. The press is the invention of Gustav Komorek. The output of the plant in 1911 was only incidental to the demonstration operations.

Continental Coal Co., Chicago, Ill.—This company was organized for the purpose of exploiting a secret process, the invention of E. J. Hoffman. No plant had been constructed at the close of 1911.

Knickerbocker Briquetting Co., Murphysboro, Ill.—This plant was first described in Survey Bulletin 316 and originally was located at Stapleton, Long Island, N. Y. The equipment was moved to Murphysboro in 1909, but was destroyed by fire in 1911. The output in 1911 was about 800 tons. The material used was 95 per cent of bituminous slack Illinois coal and 5 per cent of coal-tar pitch.

Indianapolis Pressed Fuel Co.—This company began operations in 1906, but constructed the present plant in November, 1908. The press is the invention of George W. Ladley, secretary and treasurer of the company. It is described in the report on coal briquetting for 1909 and also in the issue of the Northwestern Coal Dealer of February, 1909. Commercial operations in 1911 were on bituminous coal slack, of which about 6,000 tons were used. The mixture consists of from

94 to 95 per cent of slack and from 5 to 6 per cent of coal-tar pitch. In the commercial operations the plant was used during 1911 for making tests of everything from lignite to anthracite, with various binders, such as water-gas pitch, asphaltic pitch, sulphide liquor, cell pitch, petroleum, starch, etc. The plant was burned in July, 1911, but steps were immediately taken to rebuild it upon an enlarged and improved plan.

Fertile Clay & Peat Co., Fertile, Iowa.—As indicated by its title, this company is interested in the briquetting of peat. About 200 short tons of peat briquets were made at its plant in 1911, without a binder.

American Coal Boulet Co., Phoenix mine, Md.—This is a recently constructed plant which has not been described in the technical press nor in any previous official report. It was erected for the purpose of utilizing the bituminous slack produced at the Phoenix mines in the proportion of 95 per cent of slack and 5 per cent of water-gas pitch, although in 1911 the briquetting mixture consisted of 93.5 per cent of slack and 6.5 per cent of coal-tar pitch. The output in 1911 was more than 8,500 tons.

Detroit Coalette Fuel Co., Detroit, Mich.—The plant of this company was described in the report for 1909. It consists of a Renfrow press, with a crushing, heating, and mixing apparatus, and uses Pocahontas slack coal and coal-tar pitch in the proportion of 93 to 94 per cent of slack to 6 or 7 per cent of pitch. The plant produced in 1911 about 6,000 tons of 13-ounce briquets, or "coalettes."

Anthracite Coalette Fuel Co., St. Louis, Mo.—This is a new plant which has not been fully described in any official or technical publication. It began operations on October 5, 1910, with a daily capacity of 150 tons. The production in 1911 amounted to approximately 5,000 tons, the mixture being 91.5 per cent of anthracite culm and 8.5 per cent of coal-tar pitch.

Standard Briquet Fuel Co., Kansas City, Mo.—This plant has been previously described in the report for 1909; also in Fuel, May 18, 1909, the Black Diamond, June 12, 1909, and the American Coal Journal, January, 1910. The plant uses 94 per cent of Arkansas semianthracite coal, with 6 per cent of coal-tar pitch as a binder. The production at the present time is between 5,000 and 6,000 tons a year.

New Jersey Briquetting Co., Perth Amboy, N. J.—This plant was moved from Brooklyn, N. Y., in 1908. It was partly destroyed by fire in 1910, but was rebuilt. It operates on Lykens Valley anthracite coal dust and coal-tar pitch in the proportion of 90 per cent of the former and 10 per cent of the latter. The process, including the press, is known as the Zwoyer briquetting process. The briquets are pillow shaped and made for domestic use. The plant is described in Survey Bulletin 316.

Coal Boulet Co., New York, N. Y.—The plant of this company is described in the Black Diamond, December 17, 1910. It uses anthracite culm, with a binder the nature of which was not reported. The proportion is 95 per cent of the culm and 5 per cent of the binder The output in 1911 was about 9,000 tons.

Robert Devillers, New York, N. Y.—Mr. Devillers is one of th active promoters of the briquetting industry and has had a plant in successful operation for several years. It is described in Survey Bulletin 316, in the Coal Trade Journal, June 16, 1909, the Iron Age

February 24, 1910, and the Black Diamond, October 1, 1910. The briquets are of the small-sized eggette type, consisting of 94 per cent of anthracite culm and 6 per cent of coal-tar pitch. The output of the plant is from 12,000 to 15,000 tons annually.

Economy Coal Co., New York, N. Y.—This plant is located at the foot of West Forty-seventh Street, New York, and was operated during 1911 principally for experimental purposes. The plant was described in the report on coal briquetting for 1909.

Rock Island Coal Co., Hartshorne, Okla.—This plant was one of the pioneer commercial briquetting plants in the Middle West. It consists of a Renfrow press, was constructed under the supervision of Charles T. Malcolmson, and was fully described in Fuel, June 9, 1908, in the Black Diamond, February 27, 1909, and in Mines and Minerals, March, 1909. It uses 92 per cent of Oklahoma bituminous slack and 8 per cent of water-gas pitch. The product is sold under the trade name "Carbonets." The plant has a capacity of 80 tons per 10-hour day, but was idle during 1911 for the peculiar reason that no surplus slack was available. All of the slack, and every other kind of solid mineral fuel, was exhausted in 1910 by the prolonged strike in the coal mines of the Middle Western and the Southwestern States.

Scranton Anthracite Briquette Co., Dickson City, Pa.—This plant is by long odds the largest briquetting plant in the United States, its output in 1911 having been more than one-third of the total production of briquets in the country. The location of the plant is in close proximity to the Dickson mine of the Delaware, Lackawanna & Western Railroad Co., which furnishes the culm used at the briquetting plant. Coal-tar pitch is used as a binder, but no statement of the proportion of culm and binder is given. The briquets are eggette shaped and from 6 to 8 ounces in weight.

In an address before a meeting of the New York State and Western Pennsylvania Retail Coal Merchants' Association, held at Syracuse, N. Y., January 17, 1912, Mr. John F. Lovejoy, vice president of the Scranton Anthracite Briquette Co., gave the following sketch of the early attempts at fuel briquetting in the United States and of the briquetting plant at Dickson City, Pa.:

> Touching the briquet industry of this country. In 1870 E. F. Loiseau installed at Port Richmond, Philadelphia, the first coal-briquetting plant, using anthracite culm, with clay as a binder, pressed in egg form and weighing 8 ounces, then waterproofed with a varnish of shellac and benzine; the cost was prohibitive, and the plant finally abandoned. The Delaware & Hudson Canal Co. built a plant in 1875, which was operated spasmodically till 1880. As the product was not satisfactory, due to the briquets disintegrating in the fire, it was abandoned.
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> From that time to the present day there have been many efforts made to advance the industry by individuals with their own capital, and by the Government, which installed a practical working plant at the St. Louis Exposition for testing coals from different parts of the country and went far in obtaining data on the subject, making tests on several of the western railroads, also on the torpedo boats and battleships of our Navy. These tests are all a matter of record with the Government and may be obtained upon application.
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> In 1894 the anthracite culm banks were growing to such an extent that the Legislature of the State of Pennsylvania appointed a committee of engineers and coal men to investigate and report on the possibility of utilizing the culm banks commercially. This committee, after two years' work, reported that they could not recommend any satisfactory plan; but the work of the individual was going on and results were being accomplished in a small way and hundreds of thousands of dollars have been spent and, unfortunately, many of

the plants have been abandoned, due to the fact that a careful study of the situation and conditions from all points of view were not made. In our own case, before expending any money in the erection of a plant, it was deemed advisable to learn what the condition of the business was in this country, and, finding nothing of a successful nature, it was decided that I investigate the European plants. With this object in view I visited plants in France, Belgium, Germany, and England, making a special study of the methods used, including cost of labor, sizes of briquets, the life and repairs of machinery, and many other details connected with the business, which resulted in the purchase of a small plant in Belgium. Such of the machinery as I thought could be used I had shipped to this country. On arrival here it was gone over carefully, but the press and mixer were about the only pieces that were available for use. A demonstration testing plant was then erected in which a capacity of 5 tons per hour was obtained; different kinds of coal were tried out and briquets made. It was then decided to erect a plant of 200-ton capacity at the mines, and I contracted with the Delaware, Lackawanna & Western Railroad Co. for the delivery of the culm. Dickson City, just beyond the Scranton city line, was selected for the factory site and adjoined the dump from the Storrs mine breaker, which had been accumulating for many years back. We erected the plant, installing a press with a capacity of 25 gross tons per hour of 6-ounce (egg size) briquets, but great trouble was experienced in drying the quantity of material needed to keep the press going up to its capacity, and, to be brief, it was only after the expenditure of thousands of dollars and a great loss of time that we were able to take the material as it is flushed from the washery, at the rate of 1 ton per minute, down the sluiceway into our receiving settling tank and make a continuous process through the factory into the cars ready for shipment and use.

After making the egg-size briquets for some time and showing satisfactory results for steam-raising purposes it was decided to increase the capacity of the plant and at the same time, while designing the new press, which had a capacity of 60 tons per hour, to reduce the size of the briquet from 6 ounces to 3 ounces, i. e., between egg and stove, and on the evaporation test we found that the 3-ounce briquet exceeded the 6 ounce by over 10 per cent, so we continued that size, making about 200,000 tons. Then we tried a 2-ounce size, i. e., between stove and chestnut. These gave even better results, both for steam raising and domestic use, and we sold over 200,000 tons of this size. Last spring, realizing that generally there was a shortage of chestnut coal, and knowing that briquets of a smaller size would make a most excellent substitute, I had a set of molds made to produce the briquets we are now offering and are known as Twentieth Century Chestnut Briquets.

Downing Bros., Philadelphia, Pa.—This plant is used chiefly for demonstrating the Giles briquetting patent, about 2,000 tons having been produced in that manner during 1911. The raw material used consists of about 85 per cent of anthracite culm and 15 per cent of bituminous slack. The nature of the binder is not divulged.

Lehigh Coal & Navigation Co., Lansford, Pa.—This plant was constructed by the company for the purpose of utilizing the anthracite culm from its own mines. It was operated originally in May, 1899, but was destroyed by fire about six months later. It has been reconstructed and the new plant began its operations in August, 1911, producing during the remaining months of the year between 9,000 and 10,000 tons of briquets. The materials used consist of 94 per cent of culm and 6 per cent of coal-tar pitch. The briquets are egg shaped and weigh about 1½ ounces each. They are manufactured for domestic consumption. The new plant is described in the Black Diamond of May 10, 1911.

United Gas Improvement Co., Philadelphia, Pa.—As stated in earlier reports on the subject of briquetting, this plant was started primarily for the purpose of utilizing coke breeze produced at the gas works of the company. It is now operated on mixtures of anthracite culm and bituminous slack, the abrasive action of the coke dus on the machinery and molds making it impracticable to continue the use of breeze as a raw material in the manufacture of briquets. The mixture at present used consists of 85 per cent of the anthracite culm, 6.5 per cent of bituminous coal slack, and 8.5 per cent of water-gas pitch. The briquets are not placed upon the market, but are used by the company in its water-gas retorts.

Rhode Island Coal Co., Portsmouth, R. I.—In connection with its effort to reopen and operate the anthracite mines at Portsmouth the Rhode Island Coal Co. has added a briquetting plant to its surface equipment. No complete description of the plant has been published in the technical press nor furnished to the Survey. The company reported a production of about 16,000 tons of briquets in 1911, the material used being anthracite culm from the Portsmouth mine, with 10 per cent of coal-tar pitch.

Virginia Coal Briquetting Co., Richmond, Va.—This company has been organized for the purpose of briquetting Pulaski County (Va.) semianthracite coal (75 per cent) and Pocahontas semibituminous coal (25 per cent), with the Hite patented binder, with which it is claimed a smokeless fuel can be obtained. It was expected that the plant would be put in operation April 12, 1912.

United Collieries Co., Seattle, Wash.—This plant was completed in 1911 for utilizing a process developed by the company for briquetting bituminous washed sludge or slack and washed lignite. The press and other machinery have been specially designed by the company and the plant has a capacity of 200 tons of briquets per day of 10 hours. The company reports that its product has been well received and expects that during the coming winter the demand will be equal to the entire capacity of the plant. Specially prepared coal-tar pitch (4 to 5 per cent) and gluten, also specially prepared (0.5 to 1 per cent), constitute the binder used in making the briquets.

Stott Briquette Co., Superior, Wis.—This plant was briefly described in the report for 1909, its operation having begun in November of that year. It utilizes screenings from the coal yards at the head of Lake Superior, the average mixture consisting of 87 per cent of anthracite culm, 4 per cent of bituminous slack, and 9 per cent of coal-tar pitch. The plant was described in the Black Diamond of September 11, 1909, and in the Coal Trade Journal of June 22 of the same year. The output in 1911 was approximately 15,000 tons.

The following plants, which have been mentioned in previous reports of the Survey and which are still in existence, were not operated in 1911: Arizona Copper Co., Clifton, Ariz.; Semet-Solvay Co., Detroit, Mich.; United States Fuel Briquette Co., Deer Lodge, Mont.; Black Diamond Briquette Co., Dallas, Tex.

In connection with the development of briquetting in the United States the experimental work which is being carried on by the school of mines at the North Dakota University is of interest. This work is under the directorship of Prof. E. J. Babcock, dean of the college of mining engineering. In a letter to the writer, dated April 23, 1912, Prof. Babcock says:

> We are doing a very large amount of research work at this plant on the use of various binders, the best methods of preparing the coal, as well as the best methods of mining and pressing. We are improving our plant and enlarging it at the present time, so as to get data more nearly approaching that of a commercial plant. Thus far we have made but small quantities of briquets, but by the methods which we are working out we have gotten very excellent results.

> The briquets are of high grade and stand well in the fire and on exposure to atmospheric agencies. They are of high heat value, being raised from 7,500 or 7,800 in the raw lignite to about 12,000 B. t. u. in the finished briquets. After the improvements are completed which we are now making our experimental plant will be able to run uniformly at a rate of 10 tons per day. We operate a gas plant in connection with the lignite plant, thereby generating gas from lignite and briquetting the residue. This residue gives a high heat unit briquet.
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> We condense about 1½ tons of raw lignite into 1 ton of briquets in this manner. The gas and other by-products are saved. We derive approximately 10,000 cubic feet of 400 B. t. u. gas per ton of reasonably dry lignite. We have tried a great variety of binders and methods.

A bulletin giving a complete description of the plant and the proposed work was published by the University of North Dakota in 1911.

Berwind Fuel Co., Superior, Wis.—This plant has been designed by and is being built under the supervision of Mr. C. T. Malcolmson, of the Roberts & Schaefer Co. The construction of all the buildings will be of steel, reenforced concrete, and brick, with no wood except for platforms, so that the plant will be entirely permanent and fireproof. It will be so arranged as to take the screenings from the dock by means of a belt conveyer, pass these screenings through the proper drying equipment, manufacture them into briquets, and deliver the briquets either direct to the cars or to a storage pile alongside the plant. All of the conveying equipment will be of sufficient capacity to handle 125 tons of coal per hour. The plant has been designed for two machines, and such of the equipment as is common to both machines will be installed immediately. A Rutledge briquetting press having a capacity of 40 tons per hour of 13-ounce briquets will be put in. This machine is manufactured by the St. Louis Briquet Machine Co., and has already been described in the report on coal briquetting in 1909. The first press was set up at the plant of the New Staunton Coal Co., at Livingston, Ill. The design of the press has not been changed, but the Superior machine will be much heavier in all parts than the one at Livingston and will have a larger tonnage, although making a smaller briquet. This press is of the continuous mold type, having the economy of operation of the plunger press and the large capacity of the rotary press. The briquets will be made exclusively of Berwind Pocahontas coal and coal-tar pitch as a binder. The dry process of mixing the coal and the binder will be used. On account of the high pressure obtainable with the Rutledge press and the care which has been exercised in the design of the plant, it will not be necessary to use over 5 per cent binder to obtain satisfactory merchantable briquets. The briquets will be loaded into box cars by a box-car loader, and provision is being made to take care of the briquets during the shifting of cars. A movable boom, or stacker, traveling under its own power, will be installed alongside the briquet plant, operating across the dock. This will serve to store 15,000 tons of briquets which will be reclaimed from the storage by the coal-handling machinery already on the dock. The briquets will be sold in competition with prepared Pocahontas coal and anthracite, and on account of their cleanliness, freedom from smoke, and high fuel value are expected to compete successfully with anthracite. It is the intention of the Berwind Fuel Co. to double the capacity of this plant as soon as the superiority of the fuel has been demonstrated in a commercial way.

NATURAL GAS.

INTRODUCTION.

By David T. Day.

GENERAL CONDITIONS.

The report on the natural-gas industry for 1910 emphasized the development of a great gas field in California and the marked increase in the capital invested in the production of natural gas, especially for pumping stations in the Mid-Continent field. This increased investment of capital has been necessary in order to keep pace with the increasing demands for natural gas from the domestic consumers, especially from those for whom natural gas is nearly indispensable for manufacturing purposes. These additional investments have been sufficient to continue the normal increase in quantity of natural gas produced and its total value. Thus, in 1910, the quantity of gas usefully produced in the United States was 509,155,309,000 cubic feet, valued, in first hands, at $70,756,158. In 1911 the quantity was practically the same, 508,353,241,000 cubic feet, but its value increased to $74,127,534, a gain of 4.76 per cent. The increase in demands for natural gas from consumers of all kinds makes the supply of gas a matter of growing seriousness. Beyond question the natural gas that can be furnished in many of the fields of the United States is simply a function of the capital invested in natural-gas lines, and especially in power plants for pumping the gas.[1] Unfortunately, the safety of such large investments decreases in proportion as the increased demand becomes indicative of a failing supply. In Ohio and Indiana the yield has decreased so rapidly as to stop the investment of the further capital necessary to stimulate production. It is evident, in those States, that no reasonable amount of investment could adequately offset the decline. One important feature of the productive conditions of natural gas during 1911 was the excessive demand for it in Kansas City. This caused the board of public utilities to create a commission headed by Erasmus Haworth, State geologist of Kansas, to investigate the probable duration of the supply of gas to Kansas City. Haworth expresses the view in his report that a supply of natural gas sufficient for the needs of the city is not possible for longer than three or four years. It is assumed that this opinion is based on the productive capacity of the known fields and those which, in his judgment, are likely to be discovered. This agitation of the question of a natural-gas supply for domestic consumption and for manuturing in eastern Kansas makes this region the center of study of the problems of investment in gas production and of the prevention of waste of this fuel. From this study a great deal of valuable technical information on this subject must result within the next year, and further reference to this interesting field will be made elsewhere in this report.

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[1] The subject of natural-gas compression has been treated fully in a paper by E. D. Eland, entitled "Compressing natural gas" (Proc. Eng. Soc. Western Pennsylvania). The paper also gives a bibliography of this subject.

One important result of this agitation in the Mid-Continent field is a lessening of the hostilities between the gas men and the oil men, by which leasing has become practicable, with the natural gas going to one company and the oil to another. Earnest pleas have been made by both gas and oil producers in Oklahoma to the Secretary of the Interior for modifying the restrictions as to the amount of land which a gas company can lease on Indian lands for developing natural gas.

Third in order of interest in the utilization of the natural-gas resources of the United States is the extension northeastward from the Caddo field in Louisiana of gas lines as far as Little Rock, Ark., in the ultimate direction of St. Louis.

WASTE OF NATURAL GAS.

Recent literature on natural gas has been limited chiefly to essays on the magnitude of its waste. They have been timed, perhaps, for some sensational effect, but have been of slight importance as suggestive of methods of preventing waste.

In contrast in this respect has been the increasing investment of large amounts of capital by the producers of gas, always with a view to checking waste and to rendering useful and profitable a larger and larger percentage of the total yield from the ground. The effect of these costly conserving efforts has been sufficient to limit the various kinds of waste to those for which there is some definite reason—that is, where some formidable obstacle is offered to the conservation of the gas.

The chief causes of the waste of natural gas are as follows:

1. *Free escape of gas from natural-gas wells that have not been closed in.*—A few years ago the development of any gas field with strong pressure was sure to result in one or more wild wells with great waste of gas, caused by inability to shut in the well. The waste thus caused has been so enormous as to stimulate great ingenuity in developing means of controlling such wells, so that it is not likely any gas wells of this character will in the future remain uncontrolled more than 30 days after being struck—even this length of time will be most exceptional. Only one wild well of this character now remains. This is one of the first wells drilled in the Caddo field. Its pressure has greatly diminished. No good excuse can be offered for the continued failure to close it, inasmuch as the companion wild well, not far distant in the Caddo field, was finally closed without any considerable difficulty. The obstacle to closing this wild well in the Caddo field is simply the cost involved as compared to the gain to the company owning the well. Unquestionably, the well should be closed. If this can not be done by invoking the recent State law, community interests should subscribe the necessary outlay for the general benefit of the field.

2. *Free escape of gas from oil wells.*—This is the greatest cause of gas waste in the United States. It is a normal incident of great importance in the opening of nearly all oil fields. In the opening

stage of development of an oil and gas region, the situation is entirely in the hands of the oil man, as opposed to the gas man. The oil man's sympathy concerning the conservation of gas is distinctly a negative quantity, because of his belief that if the gas be allowed to escape, oil will usually follow it into the hole. This has been frequently the case; but quite as frequently salt water has followed the gas, with serious damage to the field. This free escape of gas from oil wells also remains as a continuing factor through the entire life of the field, for, in contrast to the great gas pressure frequently found in the opening of an oil field, the pressure later on is too small to yield an amount of gas that can be sold at great profit; hence the oil man allows it to escape.

The obstacle to the saving of this "casing-head" gas consists in the interference during the process with the production of oil, and weight for weight or dollar for dollar the oil produced is generally very much greater than the gas.

As to a remedy, legislation has been enacted in many States compelling the saving of this gas. Frequently this legislation has been so drastic in character as to prevent its practical enforcement. Reasonable laws controlling this waste can be enforced. This has been shown particularly in Indiana. An example has been given in Oklahoma of too drastic laws, leading to poor enforcement of any State regulations. Altogether, the most hopeful remedy that has been put into force in recent years consists in the cooperation of gas companies with the oil producers, by which this casing-head gas is being saved to a continually greater extent in the eastern fields. In Oklahoma a form of lease is in operation among oil and gas companies, by which much of this casing-head gas and that from isolated gas wells in oil fields is turned over at a profit by the oil man to the gas company. Again, the increased value of this casing-head gas in most oil fields, as a source of gasoline, is also aiding its conservation. Undoubtedly, increased technical efficiency will lead (as at present in a few localities in Pennsylvania) to the extraction of crude oil and gas from the same well by pumping under partial vacuum for the purpose of extracting the natural gas, gasoline, and even small quantities of heavier oils, which are volatilized under this greatly diminished pressure.

3. *Abuse of gas by the use of its pressure to drive steam engines in oil fields.*—This form of waste has been dealt with so severely by legislation that it has practically ceased to exist, as has also the following abuse.

4. *Abuse by jetting the gas into oil wells for the purpose of a gas lift instead of an air lift in oil production.*—The objection met with by the would-be conservator of natural gas in this case is that where there is no immediate market for the gas, it is considered to have no value. The oil producer considers the waste in this manner as absolutely justified, and he takes the risk of punishment in temporarily continuing these practices. The remedy in most cases consists simply in an application of existing law.

5. *Wasteful installation of gas burners and lights in oil-well drilling.*—The temporary character of this work and the great necessity for a plentiful supply of fuel and for abundant lighting of the well practically takes this out of the category of waste. It is an emergency means to a worthy end, and the waste has been greatly exaggerated and calls for little remedial notice.

6. *Waste by selling at flat rate.*—The idea prevails that waste of natural gas is a simple matter, consisting of a leakage of gas from the earth in many gas wells. Several very important items of waste, however, are due to the consumers after the gas has been carefully gathered from the wells and after it has become more valuable by transportation to the point of consumption.

Under the form of sale at flat rate there is no incentive to economical use and the objection to economizing the gas can only be met by metering the production. In Kansas and other places where the supply is becoming inadequate, the abolition of the flat rate must be put into effect rapidly.

7. *Waste from open grates, inefficient furnaces, improperly adjusted mixers, and other causes, by consumers.*—The waste in consumption is most reprehensible because the gas is worth more per unit than at any oil field, all of the gas supplied has an abundant market, and the supply is usually less than the demand. The best way to remedy this waste is through agitation in the public press and by most careful efforts on the part of the distributing company, and this waste can be remedied if the consumption be made more efficient. The supply in most gas regions of the United States could thus be doubled, and there would be fewer cases of deficient supply.

8. *Overheated buildings.*—This especial form of consuming a wasteful quantity of gas deserves most careful consideration, and its remedy lies in education toward better sanitary conditions of residences and factories.

STATISTICS OF PRODUCTION.

By B. Hill.

PRODUCTION AND CONSUMPTION.

The following table gives, by States, the total value of the natural gas produced in the entire country from 1884 to 1911, inclusive:

Approximate value of natural gas produced in the United States, 1884–1911, by States.

State.	1884	1885	1886	1887	1888	1889	1890
Pennsylvania	$1,100,000	$4,500,000	$9,000,000	$13,749,500	$19,282,375	$11,593,989	$9,551,025
New York		196,000	210,000	333,000	332,500	530,026	552,000
Ohio		100,000	400,000	1,000,000	1,500,000	5,215,669	4,684,300
West Virginia		40,000	60,000	120,000	120,000	12,000	5,400
Illinois		1,200	4,000			10,615	6,000
Indiana			300,000	600,000	1,320,000	2,075,702	2,302,500
Kansas			6,000			15,873	12,000
Missouri						35,687	10,500
California						12,680	33,000
Kentucky and Tennessee						2,580	30,000
Texas and Alabama						1,728	
Arkansas and Wyoming						375	
Utah							
Colorado							
South Dakota							
Indian Territory and Oklahoma							
Louisiana							
Other	360,000	20,000	32,000	15,000	75,000	1,600,175	1,606,000
Total	1,460,000	4,857,200	10,012,000	15,817,500	22,629,875	21,107,099	18,792,725

Approximate value of natural gas produced in the United States, 1884–1911, by States—Continued.

State.	1891	1892	1893	1894	1895	1896	1897
Pennsylvania	$7,834,016	$7,376,281	$6,488,000	$6,279,000	$5,852,000	$5,528,610	$6,242,543
New York	280,000	216,000	210,000	249,000	241,530	256,000	200,076
Ohio	3,076,325	2,136,000	1,510,000	1,276,100	1,255,700	1,172,400	1,171,777
West Virginia	35,000	70,500	123,000	395,000	100,000	640,000	912,528
Illinois	6,000	12,988	14,000	15,000	7,500	6,375	5,000
Indiana	3,942,500	4,716,000	5,718,000	5,437,000	5,203,200	5,043,635	5,009,208
Kansas	5,500	40,795	50,000	86,600	112,400	124,750	105,700
Missouri	1,500	3,775	2,100	4,500	3,500	1,500	500
California	30,000	55,000	62,000	60,350	55,000	55,682	50,000
Kentucky and Tennessee	38,993	43,175	68,500	89,200	98,700	99,000	90,000
Texas and Alabama	....	100	50	50	20	....	....
Arkansas and Wyoming	250	100	100	100	100	60	40
Utah	....	....	500	500	20,000	20,000	15,050
Colorado	....	....	....	12,000	7,000	4,500	4,000
South Dakota	....	....	....	....	....	....	....
Indian Territory and Oklahoma	....	....	....	....	....	....	....
Louisiana	....	....	....	....	....	....	....
Other	250,000	200,000	100,000	50,000	50,000	50,000	20,000
Total	15,500,084	14,870,714	14,346,250	13,954,400	13,006,650	13,002,512	13,826,422

State.	1898	1899	1900	1901	1902	1903	1904
Pennsylvania	$6,806,742	$8,337,210	$10,215,412	$12,688,161	$14,352,183	$16,182,834	$18,139,914
New York	229,078	294,593	335,367	293,232	346,471	493,686	522,575
Ohio	1,488,308	1,866,271	2,178,234	2,147,215	2,355,458	4,479,040	5,315,564
West Virginia	1,334,023	2,335,864	2,959,032	3,954,472	5,390,181	6,882,359	8,114,249
Illinois	2,498	2,067	1,700	1,825	1,844	3,310	4,745
Indiana	5,060,969	6,680,370	7,254,539	6,954,566	7,081,344	6,098,364	4,342,409
Kansas	174,640	332,592	356,900	659,173	824,431	1,123,849	1,517,643
Missouri	145	290	547	1,328	2,154	7,070	6,285
California	65,337	86,891	79,083	67,602	120,648	104,521	114,195
Kentucky and Tennessee	103,133	125,745	286,243	270,871	365,656	390,601	322,404
Texas and Alabama	765	8,000	20,000	18,577	14,953	13,851	14,082
Arkansas and Wyoming	....	....	....	....	....	2,460	6,515
Utah	7,875	....	....	....	....	....	....
Colorado	3,300	1,480	1,800	1,800	1,900	14,140	14,300
South Dakota	....	3,500	9,817	7,255	10,280	10,775	12,215
Indian Territory and Oklahoma	....	....	....	....	360	1,000	49,665
Louisiana	....	....	....	....	....	....	....
Other	20,000	....	....	....	....	....	....
Total	15,296,813	20,074,873	23,698,674	27,066,077	30,867,863	35,807,860	38,496,760

State.	1905	1906	1907	1908	1909	1910	1911
Pennsylvania	$19,197,336	$18,558,245	$18,844,156	$19,104,944	$20,475,207	$21,057,211	$18,010,796
New York	623,251	672,795	766,157	959,280	1,222,666	1,678,720	1,418,767
Ohio	5,721,462	7,145,809	8,718,562	8,244,835	9,966,938	8,626,954	9,367,347
West Virginia	10,075,804	13,735,343	16,670,962	14,837,130	17,538,565	23,816,553	28,451,907
Illinois	7,223	87,211	143,577	446,077	644,401	613,642	687,726
Indiana	3,094,134	1,750,715	1,572,605	1,312,507	1,616,903	1,473,403	1,192,418
Kansas	2,261,836	4,010,986	6,198,583	7,691,587	8,293,846	7,755,367	4,854,534
Missouri	7,390	7,210	17,010	22,592	10,025	12,611	10,496
California	133,696	134,560	168,397	307,652	446,933	476,697	800,714
Texas	14,409	150,695					1,014,945
Alabama			178,276	236,837	453,253	956,683	858,145
Louisiana	1,500						
Kentucky	237,290	287,501	380,176	424,271	485,192	456,293	407,689
Tennessee	300	300	300	350	350	300	300
Arkansas and Wyoming	21,135	34,500	126,582	164,930	226,925	301,151	295,858
Colorado	20,752	22,800					
South Dakota	15,200	15,400	19,500	24,400	16,164	31,999	16,984
Oklahoma	130,137	259,862	417,221	860,159	1,806,193	3,490,704	6,731,770
North Dakota	....	....	235	2,480	3,025	7,010	5,738
Oregon	....	....	100	250	50	....	....
Iowa	....	....	....	93	50	40	70
Michigan	....	....	....	....	255	820	1,330
Total	41,562,855	46,873,932	54,222,399	54,640,374	63,206,941	70,756,158	74,127,534

It is the rule in the reports of this series on the production of various minerals to give the value of the product at the point of production. This is not practicable in the case of natural gas for many reasons. By that system, for example, it would not be possible to state quantitatively the uses to which the gas has been put, information which has proved of great interest. Therefore, the value of the gas is taken at the point where it is consumed and includes the transportation cost from the point of production to the place of consumption. Inasmuch as in many places the gas is consumed where it is produced and in other places it is piped hundreds of miles to points of consumption, the price per unit necessarily varies between exceptionally wide limits.

The following table shows the production and consumption of natural gas in 1910 and 1911, by States:

Quantity and value of natural gas produced and consumed in the United States in 1910 and 1911, by States.

1910.

State.	Produced.			Consumed.		
	Quantity, M cubic feet.	Cents per M cu. ft.	Value.	Quantity, M cubic feet.	Cents per M cu. ft.	Value.
West Virginia	190,705,869	12.49	$23,816,553	77,067,756	7.16	$5,617,910
Pennsylvania	126,866,729	16.60	21,057,211	168,875,559	14.17	23,934,691
Ohio	48,232,406	17.89	8,626,954	108,074,660	19.63	21,210,965
Kansas	59,380,157	13.06	7,755,367	[a] 83,340,045	11.20	9,335,027
Oklahoma	50,429,646	6.92	3,490,704	26,469,758	7.22	1,911,044
New York	6,009,598	27,93	1,678,720	14,194,804	27.92	3,963,872
Indiana	5,760,252	25,58	1,473,403	5,760,252	25.58	1,473,403
Louisiana Texas Alabama	8,110,502	11.79	956,683	8,110,502	11.80	956,683
Illinois	6,723,286	9.13	613,642	6,723,286	9.13	613,642
California	2,764,507	17.24	476,697	2,764,507	17.24	476,697
Kentucky	1,356,771	33.63	456,293	4,958,594	18.32	908,293
Arkansas Colorado Wyoming	2,704,948	11.13	301,151	2,704,948	11.13	301,151
South Dakota	43,374	73.77	31,999	43,374	73.77	31.999
Missouri	47,144	26.75	12.611	47.144	26.75	12.611
North Dakota	17.620	39.78	7,010	17,620	39.78	7,010
Michigan	1,220	67.21	820	1,220	67.21	820
Tennessee	1,200	25.00	300	1,200	25.00	300
Iowa	80	50.00	40	80	50.00	40
Total	509,155,309	13.90	70,756,158	509,155,309	13.90	70,756,158

1911.

State.	Produced.			Consumed.		
	Quantity, M cubic feet.	Cents per M cu. ft.	Value.	Quantity, M cubic feet.	Cents per M cu. ft.	Value.
West Virginia	207,112,576	13.74	$28,451,907	80,868,645	7.72	$6,240,152
Pennsylvania	104,018,296	17.32	18,010,796	154,475,376	15.18	23,446,001
Ohio	49,449,749	18.94	9,367,347	112,123,029	20.33	22,792,270
Oklahoma	67,275,608	10.01	6,731,770	28,213,871	7.42	2,092,603
Kansas	[a] 38,799,406	12.51	4,854,534	[a] 77,861,143	12.19	9,493,701
New York	5,239,915	27.07	1,418,767	14,894,303	28.71	4,276,324
Indiana	4,365,339	27.32	1,192,418	4,365,339	27.32	1,192,418
Texas	5,503,393	18.44	1,014,945	5,503,393	18.44	1,014,945
Louisiana Alabama	9,786,041	8.77	858,145	9,786,041	8.77	858,145
California	6,389,820	12.53	800,714	6,389,820	12.53	800,714
Illinois	6,762,361	10.17	687,726	6,762,361	10.17	687,726
Kentucky	1,275,397	31.97	407,689	4,734,580	19.05	901,759
Arkansas Colorado Wyoming	2,293,662	12.90	295,858	2,293,662	12.90	295,858
South Dakota	25,547	66.48	16,984	25,547	66.48	16.984
Missouri	50,315	20.86	10,496	50,315	20.86	10,496
North Dakota	13,526	42.42	5,738	13,526	42.42	5,738
Michigan	1,730	76.88	1,330	1,730	76.88	1,330
Tennessee	1,200	25.00	300	1,200	25.00	300
Iowa	140	50.00	70	140	50.00	70
Total	508,364,021	14.58	74,127,534	508,364,021	14.58	74,127,534

[a] Includes gas piped from Kansas and consumed in Missouri; also gas piped from Oklahoma into Kansas and Missouri.

The following tables show the distribution of natural gas consumed in 1910 and 1911, by States:

Distribution of natural gas consumed in the United States in 1910, by States.

State.	Producers.			Consumers.		Gas consumed.		
						Domestic.		
	Reporting gas wells.	Reporting gas from oil wells.	Total.	Domestic.	Industrial.	Quantity, M cubic feet.	Cents per M cubic feet.	Value.
Pennsylvania	819	1,584	2,403	321,430	4,102	43,404,565	25.3	$10,972,250
Ohio	1,630	638	2,268	475,505	3,187	60,539,597	25.0	15,145,537
Kansas [a]	204	38	242	186,333	1,412	23,816,079	21.8	5,206,010
West Virginia [b]	241	189	430	86,778	2,659	13,637,059	17.4	2,377,276
New York	273	375	648	106,538	717	12,247,528	29.7	3,646,180
Oklahoma	168	343	511	38,617	1,557	5,373,327	16.9	909,862
Indiana [c]	1,027	117	1,144	36,054	282	4,315,403	30.1	1,299,247
Kentucky	47	21	68	27,961	112	2,574.352	27.9	718,657
Illinois [d]	207	227	434	10,109	261	1,266,057	21.9	278,377
Louisiana	21	....	21	8,547	320	1,616,332	31.8	514,782
Texas	19	20	39	14,719	133			
Alabama	7	....	7	95	6			
California	30	124	154	8,292	217	245,738	79.2	194,631
Arkansas	9	....	9	4,422	121	722,895	24.8	179,324
Colorado	5	11	16	1,051	13			
Wyoming	5	2	7	353	4			
South Dakota	37	....	37	371	8	23,074	77.6	17,899
Missouri	33	1	34	322	5	22,704	28.6	6,501
North Dakota	14	....	14	212	3	16,620	39.8	6,610
Michigan	8	1	9	7	1	420	100.0	420
Tennessee	5	....	5	2	....	1,200	25.0	300
Iowa	5	....	5	4	....	80	50.0	40
Total	4,814	3,691	8.505	1,327,722	15,120	169,823,030	24.4	41,473,903

State.	Gas consumed—Continued.					
	Industrial.			Total.		
	Quantity, M cubic feet.	Cents per M cubic feet.	Value.	Quantity, M cubic feet.	Cents per M cubic feet.	Value.
Pennsylvania	125,470,994	10.3	$12,962,441	168,875,559	14.17	$23,934,691
Ohio	47,535,063	12.8	6,065,428	108,074,660	19.63	21,210,965
Kansas [a]	59,523,966	6.9	4,129,017	83,340,045	11.20	9,335,027
West Virginia [b]	63,430,697	5.1	3,240,634	77,067,756	7.29	5,617,910
New York	1,947,276	16.3	317,692	14,194,804	27.92	3,963,872
Oklahoma	21,096,431	4.7	1,001,182	26,469,758	7.22	1,911,044
Indiana [c]	1,444,849	12.1	174,156	5,760,252	25.58	1,473,403
Kentucky	2,384.242	8.0	189,636	4,958,594	18.32	908,293
Illinois [d]	5,457,229	6.1	335,265	6,723,286	9.13	613,642
Louisiana	6,494,170	6.8	441,901	8,110,502	11.80	956,683
Texas						
Alabama						
California	2,518,769	11.2	282,066	2,764,507	17.24	476,697
Arkansas	1,982,053	6.1	121,827	2,704,948	11.13	301,151
Colorado						
Wyoming						
South Dakota	20,300	69.5	14,100	43,374	73.77	31,999
Missouri	24,440	25.0	6,110	47,144	26.75	12,611
North Dakota	1,000	40.0	400	17,620	39.78	7,010
Michigan	800	50.0	400	1,220	67.21	820
Tennessee	....	....	....	1,200	25.00	300
Iowa	....	....	....	80	50.00	40
Total	339,332,279	8.63	29,282,255	509,155,309	13.90	70,756,158

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[a] Includes the consumption of gas piped from Kansas to Missouri and from Oklahoma to Kansas and Missouri.

[b] Includes the consumption of gas piped from West Virginia to Maryland.

[c] Includes the consumption of gas piped from Indiana to Chicago, Ill.

[d] Includes the consumption of gas piped from Illinois to Vincennes, Ind.

Distribution of natural gas consumed in the United States in 1911, by States.

State.	Number of producers.	Consumers.		Gas consumed.		
				Domestic.		
		Domestic.	Industrial.	Quantity, M cubic feet.	Cents per M cubic feet.	Value.
Pennsylvania	1,067	330,537	4,597	41,026,643	26.02	$10,676,168
Ohio	1,900	577,263	3,634	57,791,210	27.40	15,837,421
Kansas [a]	232	199,523	907	27,688,371	22.82	6,317,307
West Virginia [b]	340	87,438	1,566	13,870,321	18.12	2,513,689
New York	302	116,314	208	13,479,789	30.39	4,096,162
Oklahoma	204	44,854	1,507	5,816,723	16.88	981,976
Indiana [c]	1,094	31,576	143	3,512,633	29.92	1,050,947
Texas	29	22,972	303	1,590,858	39.73	631,986
Kentucky	74	41,201	70	2,193,859	30.57	670,648
Louisiana [d]	27	17,964	442	1,369,498	22.84	312,782
Alabama	7	105	4			
California	22	10,598	307	543,392	58.42	317,467
Illinois [e]	225	10,078	293	1,263,652	22.85	288,802
Arkansas	5	5,008	90	737,303	25.41	187,331
Colorado	17	1,107	14			
Wyoming	7	354	5			
South Dakota	34	393	9	18,480	70.80	13,084
Missouri	44	551	13	44,868	20.44	9,173
North Dakota	16	255	1	13,276	42.47	5,638
Michigan	20	16	1	930	100.00	930
Tennessee	4	1	....	1,200	25.00	300
Iowa	5	2	....	140	50.00	70
Total	5,675	1,498,110	14,114	170,963,146	25.68	43,911,881

State.	Gas consumed.					
	Industrial.			Total.		
	Quantity, M cubic feet.	Cents per M cubic feet.	Value.	Quantity, M cubic feet.	Cents per M cubic feet.	Value.
Pennsylvania	113,448,733	11.26	$12,769,833	154,475,376	15.18	$23,446,001
Ohio	54,331,819	12.80	6,954,849	112,123,029	20.33	22,792,270
Kansas [a]	50,172,772	6.33	3,176,394	77,861,143	12.19	9,493,701
West Virginia [b]	66,998,324	5.56	3,726,463	80,868,645	7.72	6,240,152
New York	1,414,514	12.74	180,162	14,894,303	28.71	4,276,324
Oklahoma	22,397,148	4.96	1,110,627	28,213,871	7.42	2,092,603
Indiana [c]	852,706	16.59	141,471	4,365,339	27.32	1,192,418
Texas	3,912,535	9.79	382,959	5,503,393	18.44	1,014,945
Kentucky	2,540,721	9.10	231,111	4,734,580	19.05	901,759
Louisiana [d]	8,416,543	6.48	545,363	9,786,041	8.77	858,145
Alabama						
California	5,846,428	8.27	483,247	6,389,820	12.53	800,714
Illinois [e]	5,498,709	7.25	398,924	6,751,581	10.19	687,726
Arkansas	1,556,359	6.97	108,527	2,293,662	12.90	295,858
Colorado						
Wyoming						
South Dakota	7,067	55.19	3,900	25,547	66.48	16,984
Missouri	5,447	24.29	1,323	50,315	20.86	10,496
North Dakota	250	40.00	100	13,526	42.42	5,738
Michigan	800	50.00	400	1,730	76.88	1,330
Tennessee	....	....	....	1,200	25.00	300
Iowa	....	....	....	140	50.00	70
Total	337,400,875	8.96	30,215,653	508,353,241	14.58	74,127,534

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[a] Includes the consumption of gas piped from Kansas to Missouri and from Oklahoma to Kansas and Missouri.

[b] Includes the consumption of gas piped from West Virginia to Maryland.

[c] Includes the consumption of gas piped from Indiana to Chicago, Ill.

[d] Includes the consumption of gas piped to Texas from Louisiana and to Arkansas from Louisiana.

[e] Includes the consumption of gas piped from Illinois to Vincennes, Ind.

The following table gives the distribution of gas consumed for industrial purposes in 1910 and 1911, by States:

Distribution of gas consumed for industrial purposes in 1910 and 1911, by States.

1910.

State.	Manufacturing.			Other industrial (power).			Total industrial.		
	Quantity, M cubic feet.	Cents per M cubic feet.	Value.	Quantity, M cubic feet.	Cents per M cubic feet.	Value.	Quantity, M cubic feet.	Cents per M cubic feet.	Value.
Pennsylvania	115,465,481	10.1	$11,690,116	10,005,513	12.7	$1,272,325	125,470,994	10.3	$12,962,441
Ohio	41,874,927	12.7	5,298,299	5,660,136	13.6	767,129	47,535,063	12.8	6,065,428
Kansas	53,505,871	6.7	3,588,355	6,018,095	9.0	540,662	59,523,966	6.9	4,129,017
West Virginia	52,473,928	5.0	2,671,607	10,956,769	5.2	569,027	63,430,697	5.1	3,240,634
New York	408,943	17.4	71,063	1,538,333	16.0	246,629	1,947,276	16.3	317,692
Oklahoma	12,410,219	4.3	531,983	8,686,212	5.4	469,199	21,096,431	4.7	1,001,182
Indiana	422,363	15.1	63,667	1,022,486	10.8	110,489	1,444,849	12.1	174,156
Kentucky	2,226,062	7.4	165,320	158,180	15.4	24,316	2,384,242	8.0	189,636
Illinois	925,946	9.0	83,763	4,531,283	5.6	251,502	5,457,229	6.1	335,265
Louisiana Texas Alabama	2,083,481	9.1	189,704	4,410,689	5.7	252,197	6,494,170	6.8	441,901
California	....	......	....	2,518,769	11.2	282,066	2,518,769	11.2	282,066
Arkansas Colorado Wyoming	(a)	......	(a)	1,982,053	6.1	121,827	1,982,053	6.1	121,827
South Dakota	....	......	....	20,300	69.5	14,100	20,300	69.5	14,100
Missouri	....	......	....	24,440	25.0	6,110	24,440	25.0	6,110
North Dakota	....	......	....	1,000	40.0	400	1,000	40.0	400
Michigan	....	......	....	800	50.0	400	800	50.0	400
Tennessee	....	......	....	....	......	....	....	......	....
Iowa	....	......	....	....	......	....	....	......	....
Total	281,797,221	8.64	24,353,877	57,535,058	8.57	4,928,378	339,332,279	8.63	29,282,255

a Included in other industrial.

1911.

Pennsylvania	103,227,580	11.03	$11,385,045	10,221,153	13.55	$1,384,788	113,448,733	11.26	$12,769,833
Ohio	43,150,631	12.72	5,489,390	11,181,188	13.11	1,465,459	54,331,819	12.80	6,954,849
West Virginia	50,130,046	5.39	2,701,511	16,868,278	6.08	1,024,952	66,998,324	5.56	3,726,463
Kansas	46,570,417	6.12	2,849,626	3,602,355	9.07	326,768	50,172,772	6.33	3,176,394
Oklahoma	14,433,264	4.07	587,398	7,963,884	6.57	523,229	22,397,148	4.96	1,110,627
Louisiana Alabama	2,678,678	9.36	250,824	5,737,865	5.13	294,539	8,416,543	6.48	545,363
California	....	......	....	5,846,428	8.27	483,247	5,846,428	8.27	483,247
Illinois	1,388,743	8.89	123,449	4,109,966	6.70	275,475	5,498,709	7.25	398,924
Texas	(a)	......	(a)	3,912,535	9.79	382,959	3,912,535	9.79	382,959
Kentucky	1,794,551	7.51	134,768	746,170	12.91	96,343	2,540,721	9.10	231,111
New York	249,761	18.38	45,907	1,164,753	11.53	134,255	1,414,514	12.74	180,162
Indiana	281,377	16.89	47,513	571,329	16.45	93,958	852,706	16.59	141,471
Arkansas Colorado Wyoming	(a)	......	(a)	1,556,359	6.97	108,527	1,556,359	6.97	108,527
South Dakota	....	......	....	7,067	55.19	3,900	7,067	55.19	3,900
Missouri	....	......	....	5,447	24.29	1,323	5,447	24.29	1,323
Michigan	....	......	....	800	50.00	400	800	50.00	400
North Dakota	....	......	....	250	40.00	100	250	40.00	100
Total	263,905,048	8.95	23,615,431	73,495,827	8.98	6,600,222	337,400,875	8.96	30,215,653

a Included in other industrial.

The following table gives the value of natural gas consumed in the Untied States from 1906 to 1911, inclusive, by States:

Value of natural gas consumed in the United States, 1906–1911, by States.

State.	1906	1907	1908	1909	1910	1911
Pennsylvania	$21,085,077	$22,917,547	$20,678,161	$21,639,102	$23,934,691	$23,446,001
Ohio	12,652,520	15,227,780	15,166,434	18,884,312	21,210,965	22,792,270
Kansas	[a] 4,030,776	[a] 6,208,862	[a] 7,691,587	[a] 8,356,076	[a] 9,335,027	[a] 9,493,701
Missouri		17,010	22,592	10,025	12,611	10,496
West Virginia	3,720,440	[b] 3,757,977	[b] 4,020,282	[b] 5,183,054	[b] 5,617,910	[b] 6,240,152
New York	2,654,115	3,098,533	3,281,312	3,286,523	3,963,872	4,276,324
Oklahoma	247,282	406,942	860,159	1,743,963	1,911,044	2,092,603
Indiana	[c] 1,750,755	[c] 1,570,605	[c] 1,312,507	[c] 1,616,903	[c] 1,473,403	[c] 1,192,418
Texas	150,695	178,276	236,837	453,253	956,683	[d] 1,014,945 858,145
Louisiana						
Alabama						
Kentucky	287,501	380,176	424,271	695,577	908,293	901,759
California	134,560	168,397	307,652	446,933	476,697	800,714
Illinois	87,211	143,577	[e] 446,077	[e] 644,401	[e] 613,642	[e] 687,726
Arkansas	34,500	126,582	164,930	226,925	301,151	295,858
Wyoming						
Colorado	22,800					
South Dakota	15,400	19,500	24,400	16,164	31,999	16,984
North Dakota	....	235	2,480	3,025	7,010	5,738
Michigan	....	....	....	255	820	1,330
Tennessee	300	300	350	350	300	300
Iowa	....	....	93	50	40	70
Oregon	....	100	250	50	....	....
Total	46,873,932	54,222,399	54,640,374	63,206,941	70,756,158	74,127,534

[a] Includes value of gas piped from Kansas to Missouri in 1906, 1907, 1908, and 1909, and from Kansas and Oklahoma to Missouri in 1910 and 1911.
[b] Includes value of gas piped from West Virginia to Maryland.
[c] A portion of this was consumed in Chicago, Ill.
[d] Includes value of gas piped from Louisiana to Texas and Arkansas.
[e] Includes value of gas consumed in Vincennes, Ind.

COMBINED VALUE OF NATURAL GAS AND PETROLEUM.

The following table gives the value of natural gas and of petroleum and their combined value in 1910 and 1911, by States, arranged in the order of the value of the combined production:

Value of the natural gas and petroleum produced in 1910 and 1911, and their combined value, by States.

1910.

State.	Value of natural gas.	Value of crude petroleum.	Value of natural gas and crude petroleum.
West Virginia	$23,816,553	$15,720,184	$39,536,73
California	476,697	35,749,473	36,226,17
Pennsylvania	21,057,211	11,908,914	32,966,12
Oklahoma	3,490,704	19,922,660	23,413,36
Illinois	613,642	19,669,383	20,283,02
Ohio	8,626,954	10,651,568	19,278,52
Texas	956,683	6,605,755	11,136,50
Louisiana		3,574,069	
Alabama			
Kansas	7,755,367	444,763	8,200,13
New York	1,678,720	1,414,668	3,093,38
Indiana	1,473,403	1,568,475	3,041,87
Kentucky	456,293	324,684	780,97
Arkansas	301,151		638,08
Colorado		243,402	
Wyoming		93,536	
Utah	....		
South Dakota	31,999	....	31,99
Missouri	12,611	4,794	18,22
Michigan	820		
North Dakota	7,010	....	7,01
Tennessee	300	....	3
Iowa	40	....	4
Total	70,756,158	127,896,328	198,652,4

Value of the natural gas and petroleum produced in 1910 and 1911, and their combined value, by States—Continued.

1911.

State.	Value of natural gas.	Value of crude petroleum.	Value of natural gas and crude petroleum.
West Virginia	$20,451,907	$12,767,293	$41,219,200
California	800,714	38,719,080	39,519,794
Oklahoma	6,731,770	26,451,767	33,183,537
Pennsylvania	18,010,796	10,894,074	28,904,870
Illinois	687,726	19,734,339	20,422,065
Ohio	9,367,347	9,479,542	18,846,889
Texas	1,014,945	6,554,552	7,569,497
Louisiana	858,145	5,668,814	6,526,959
Alabama		....	
Kansas	4,854,534	608,756	5,463,290
New York	1,418,767	1,248,950	2,667,717
Indiana	1,192,418	1,228,835	2,421,253
Kentucky	407,689	328,614	736,303
Arkansas	295,858	....	647,999
Colorado		228,104	
Wyoming		124,037	
Utah	....		
Missouri	10,496	7,995	19,821
Michigan	1,330		
South Dakota	16,984	....	16,984
North Dakota	5,738	....	5,738
Tennessee	300	....	300
Iowa	70	....	70
Total	74,127,534	134,044,752	208,172,286

WELL RECORD.

The following table gives the record of natural-gas wells in 1911, by States:

Record of natural-gas wells in 1911, by States.

State.	Productive Dec. 31, 1910.	Drilled in 1911.			Abandoned in 1911.	Productive Dec. 31, 1911.
		Gas.	Dry.	Total.		
Alabama	18	4	8	12	5	17
Arkansas	106	5	2	7	1	110
California	54	8	6	14	2	*a* 60
Colorado	4	2	....	2	....	6
Illinois	458	69	78	147	69	458
Indiana	2,955	110	32	142	432	2,633
Iowa	6	....	....	....	....	6
Kansas	2,149	301	152	453	446	2,004
Kentucky	241	19	8	27	8	252
Louisiana	79	36	18	54	1	114
Michigan	18	6	....	6	2	*a* 22
Missouri	54	15	5	20	9	60
New York	1,411	167	53	220	50	1,528
North Dakota	19	4	2	6	....	*a* 23
Ohio	4,717	450	191	641	450	4,717
Oklahoma	509	303	143	446	94	718
Pennsylvania	10,337	832	224	1,056	360	10,809
South Dakota	40	4	....	4	3	*b* 41
Tennessee	5	....	....	....	1	4
Texas	52	19	14	33	3	68
West Virginia	4,052	870	117	987	167	4,755
Wyoming	21	2	5	7	....	23
Total	27,305	3,226	1,058	4,284	2,103	28,428

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[a] Include some artesian wells from which gas is used.

[b] Artesian wells from which gas is used.

ACREAGE CONTROLLED BY NATURAL-GAS COMPANIES.

The following table shows the number of acres of land held by natural-gas companies in 1910 and 1911, and whether the acreage was owned in fee or leased:

Acreage controlled by natural-gas companies in 1910 and 1911, by States.

State.	1910				1911			
	In fee.	Leased.	Gas rights.	Total.	In fee.	Leased.	Gas rights.	Total.
Alabama	570	23,000	....	23,570	570	66,350	....	66,920
Arkansas	....	22,027	300	22,327	600	17,217	....	17,817
California	269	1,280	....	1,549	1,321	6,400	....	7,721
Colorado	....	35	....	35	....	195	....	195
Illinois	5	81,628	25,600	107,233	4,057	198,493	25,800	228,350
Indiana	62,648	124,858	15,151	202,657	100,348	178,396	10,152	288,896
Kansas	25,825	427,464	2,370	455,659	28,340	388,750	1,925	419,015
Kentucky	1,343	137,077	....	138,420	1,940	105,348	4,045	111,333
Louisiana	17,962	337,103	27,200	382,265	22,298	575,531	22,476	620,305
Missouri	463	2,050	....	2,513	4,636	1,410	....	6,046
New York	9,275	505,603	554	515,432	8,962	589,066	985	599,013
North Dakota	....	21,200	....	21,200	....	20,000	....	20,000
Ohio	32,564	845,404	545,383	1,423,351	27,245	1,506,723	109,260	1,643,228
Oklahoma	5,967	816,047	98,396	920,410	9,743	1,022,976	114,851	1,147,570
Pennsylvania	84,994	1,464,534	400,205	1,949,733	103,595	1,372,131	557,046	2,032,772
Tennessee	500	....	....	500	500	....	....	500
Texas	7,394	395,335	54,685	457,414	3,740	153,379	361,739	518,858
West Virginia	19,673	3,042,437	286,176	3,348,286	45,005	2,537,264	816,944	3,399,213
Wyoming	1,794	1,370	....	3,164	1,320	3,570	....	4,890
Total	271,246	8,248,452	1,456,020	9,975,718	364,220	8,743,199	2,025,223	11,132,642

NATURAL-GAS INDUSTRY, BY STATES.

PENNSYLVANIA.

The oil pools of Pennsylvania also yield natural gas. Generally the quantity is sufficient to be worth saving, and the persistence of this widespread supply has been a significant factor in the continued yield of the State. In addition to this "casing-head" gas, many dry gas pools follow the general course of the oil pools in the western part of the State and are usually closely associated with the oil, but tend to extend farther east. As a rule the accumulations of natural gas follow the anticlinal structure more closely than the oil pools do.

Natural gas in commercial quantities is found in 22 counties in Pennsylvania, extending from Tioga County on the northeast to Greene County in the southwest corner.

In spite of the long time during which gas has been utilized in Pennsylvania, the quantity produced in 1911 aggregated 104,018,296,000 cubic feet, and pressures in gas wells as high as 1,200 pounds to the square inch are still obtained. In the majority of wells the pressures are very much lower, and gas is pumped from some wells at pressures below that of the atmosphere.

More gas is consumed in Pennsylvania than in any other State. In 1911 almost one-third of the gas consumed was imported from West Virginia. The report shows that in 1911 Pennsylvania consumed a total of 154,475,376,000 cubic feet of gas, valued at $23,446,001, an average price of 15.18 cents per thousand cubic feet, compared with 168,875,559,000 cubic feet, valued at $23,934,691, an average of 14.17 cents per thousand cubic feet, in 1910. By referring to the table showing the distribution of gas consumed by States, it will be seen that Pennsylvania consumed for industrial purposes in 1911 the great total of 113,448,733,000 cubic feet of gas, valued at $12,769,833, of which 103,227,580,000 cubic feet, valued at $11,385,045, was consumed in manufactures and 10,221,153,000 cubic feet, valued at $1,384,788, for power. The consumption of gas in this State for industrial purposes in 1911 was more than twice as great as that of any other State.

The number of domestic consumers supplied in this State increased from 321,430 in 1910 to 330,537 in 1911, although the quantity of gas consumed for domestic purposes was less in 1911 than in 1910. The average price of gas per thousand cubic feet advanced from 25.3 cents in 1910 to 26.02 cents in 1911.

During the year 1911 a total of 832 gas wells and 224 dry holes were completed, the number of wells at the close of the year being 10,809, as compared with 10,337 wells at the beginning of the year. The number of gas wells abandoned in 1911 was 360.

It will be of interest to note in this connection that many plants are being installed throughout the State for the production of gasoline from natural gas, the purpose being to use the surplus or waste gas produced from oil wells, for which use the gas from some of the fields of this State is so well adapted. Some statistics concerning this industry will be found in another part of this report.

Record of the natural-gas industry in Pennsylvania, 1897–1911.

Years.	Gas produced.		Gas consumed.			Wells.		
	Number of producers.	Value.	Number of consumers.		Value.	Drilled.		Productive Dec. 31.
			Domestic.	Industrial.		Gas.	Dry.	
1897	176	$6,242,543	[a]201,059	1,124	$5,392,661	314	96	2,467
1898	232	6,806,742	[a]213,410	1,021	6,064,477	373	74	2,840
1899	281	8,337,210	[a]232,060	1,236	7,926,970	467	104	3,303
1900	266	10,215,412	[a]229,730	1,296	9,812,615	513	142	3,776
1901	296	12,688,161	[a]326,912	1,743	11,785,996	660	143	4,436
1902	379	14,352,183	185,678	2,448	13,942,783	775	232	5,211
1903	414	16,182,834	214,432	2,834	16,060,196	699	126	5,910
1904	414	18,139,914	238,481	2,929	17,205,804	701	174	6,352
1905	351	19,197,336	257,416	2,845	19,237,218	765	168	6,566
1906	309	18,558,245	273,184	3,307	21,085,077	603	153	7,300
1907	344	18,844,156	295,115	3,812	22,917,547	769	180	8,051
1908	[b]572	19,104,944	307,585	4,577	20,678,161	571	147	[c]8,831
1909	[b]777	20,475,207	294,781	5,377	21,639,102	756	166	[c]9,499
1910	[b]819	21,057,211	321,430	4,102	23,934,691	857	161	[c]10,337
1911	[b]1,067	18,010,796	330,537	4,597	23,446,001	832	224	10,809

[a] Number of fires supplied.

[b] Includes 216 producers having shallow wells in Erie County for their own domestic consumption in 1908, 311 producers in 1909, 345 producers in 1910, and 399 in 1911.

[c] Includes 350 shallow wells in Erie County in 1908, 429 wells in 1909, 429 wells in 1910, and 476 in 1911.

Depth and gas pressure of wells in Pennsylvania, 1907–1911, by counties.

County.	Depth, in feet.	Pressure, in pounds.				
		1907	1908	1909	1910	1911
Allegheny	900–3,000	7– 400	1–350	10–600	10–600	10– 800
Armstrong	702–3,450	6– 800	2–600	25–900	3–800	3– 435
Beaver	700–1,500	4	...	4–600	4– 75	...
Butler	730–2,750	15– 625	15–550	30–600	6–700	4– 800
Clarion	600–3,000	3– 700	15–500	8–800	25–900	5– 900
Elk	910–3,200	49– 960	50–940	50–990	50–990	40– 900
Crawford	600–1,200	10– 200	100	1– 85	0– 85	0– 100
Erie	300–1,600					
Fayette	900–2,600	100– 550	200–550	100–700	100–650	40– 600
Cambria						
Forest	700–2,800	75– 250	85–160	15–145	10–850	6– 150
Greene	1,400–3,600	80-1,200	70–350	50–500	40–400	40– 900
Indiana	1,100–1,500	...	...	...	...	...
Jefferson	700–3,360	200– 500	325–760	10–635	100–700	60–1,200
McKean	750–3,000	20– 450	15–500	30–600	6–600	5– 850
Mercer	700–1,500	...	...	40	...	160– 250
Lawrence						
Potter	750–2,200	40– 360	100–460	60–500	50–300	35– 500
Tioga	700–1,400	350	300	250	300	13– 350
Venango	350–2,100	70– 150	40–400	20–250	10– 85	10– 500
Warren	600–3,290	10– 60	14–250	20– 50	10–190	3– 200
Washington	606–3,304	15– 100	5–400	12–500	5–800	5– 600
Westmoreland	1,800–3,300	25	10– 30	50–180	10– 25	60– 250

NEW YORK.

Natural gas is much more widely distributed than petroleum in western New York State. It is produced in about 15 counties and its occurrence has been observed in many more, extending from the extreme western end of the State, following in general the region of the lake shore as far east as Rome, in Oneida County, and as far north as Jefferson County. The gas is found in varous formations, embracing practically all of the Paleozoic systems, as represented in New York State, from the Potsdam sandstone to the Portage and Chemung of the Devonian, which are at about the top of the Paleozoic in New York. From the sands in the Upper Devonian, in Erie County, and from Wellsville and Ricebrook, in Allegany County, comes the greater portion of the gas; also from the Devonian shale in other counties along the lake shore. The amount of gas per well is comparatively small in the slate, but it is well distributed, and the fact that it is obtained at comparatively slight depth makes it accessible for the use of individual houses over a large territory. It is well known that the first industrial use of natural gas came from this formation near the town of Fredonia, in Chautauqua County, in 1821. Since 1904 deeper drilling in the Devonian shale has proved profitable to a moderate extent. By deep drilling at Silver Creek, in Chautauqua County, the red Medina sand was struck at a depth of 1,750 feet, and under it the white Medina proved to be 55 feet in depth and gave a well of about 1,000,000 cubic feet per day. Other wells drilled to the same sands have also proved remunerative. The gas is the characteristic methane, almost pure, but occasionally with a considerable percentage of hydrogen sulphide. The same condition of small wells yielding gas in these Devonian slates and in later formations exists along the lake shore in Pennsylvania and Ohio.

The wells obtained by deep drilling in the neighborhood of Cleveland, Ohio, have proved to be largely gas wells, with an occasional oil well. This has stimulated deep drilling in New York State.

The principal gas-producing counties in New York are Allegany, Cattaraugus, Chautauqua, Erie, Genesee, Livingston, Monroe, Niagara, Onondaga, Ontario, Oswego, Schuyler, Seneca, Wyoming, and Yates.

A characteristic of the New York State wells is their long life, and owing to this and to ever increasing use the total production in the State has shown a very steady increase, from a total value of $200,076 in 1897 to $1,418,767 in 1911, as shown by the tables given below. The tables also give an interesting account of the increase in the number of wells which this supply has necessitated.

The estimated quantity of gas consumed in New York in 1911 amounted to 14,894,303,000 cubic feet, valued at $4,276,324, an average of 28.71 cents per thousand cubic feet. The value of the gas produced in New York amounted to $1,418,767 in 1911, which was about one-third the value of the gas consumed within the State, the value of the gas piped into the State from Pennsylvania being $2,857,557.

The number of gas wells drilled in New York in 1911 was 167, making the number at the close of the year 1,528. During the year 53 dry holes were drilled and 50 gas wells were abandoned.

Record of natural-gas industry in New York, 1897–1911.

Year.	Gas produced.		Gas consumed.			Wells.		
	Number of producers.	Value.	Number of consumers.		Value.	Drilled.		Productive Dec. 31.
			Domestic.	Industrial.		Gas.	Dry.	
1897	41	$200,076	[a] 55,086	80	$874,617	33	7	359
1898	62	229,078	[a] 68,662	103	1,006,567	63	9	422
1899	84	294,593	[a] 76,544	121	1,236,007	36	7	447
1900	89	335,367	[a] 89,837	138	1,456,286	57	11	504
1901	114	293,232	[a] 95,161	98	1,694,925	53	14	557
1902	116	346,471	50,536	215	1,723,709	69	8	626
1903	144	493,686	57,935	208	1,944.667	75	11	700
1904	153	522,575	67,203	451	2,222,980	78	12	744
1905	148	623,251	67,848	447	2,434,894	89	17	839
1906	143	672,795	74,538	95	2,654,115	64	14	919
1907	208	766,157	83,805	155	3,098,533	61	13	1,049
1908	215	959,280	91,391	213	3,281,312	68	19	1,211
1909	282	1,222,666	92,958	570	3,286,523	86	18	1,340
1910	273	1,678,720	106,538	717	3,963,872	97	20	1,411
1911	302	1,418,767	116,314	208	4,276,324	167	53	1,528

[a] Number of fires supplied.

Depth and gas pressure of wells in New York, 1907–1911, by counties.

County.	Depth, in feet.	Pressure, in pounds.				
		1907	1908	1909	1910	1911
Allegany	600–1,700	10–150	10–200	6–300	10–300	15–150
Cattaraugus	400–2,800	5– 85	4–150	8–250	10– 90	1–120
Chautauqua	150–2,500	1–800	1–800	0–800	1–700	0–700
Erie	360–2,980	40–585	25–500	25–500	22–610	10–700
Niagara	550	....	150	150	....	....
Genesee	1,150–1,870	300–580	600	600	500	400
Livingston	345–2,000	10	1–350	15–450	10–380	100–400
Monroe	525–1,050	....	....	....	....	....
Onondaga	1,000–3,000	100	100–350	....	300–500	300–600
Ontario	650–2,300	65–425	65–510	60–480	5–400	60–440
Seneca	1,250–1,550					
Oswego	700–1,300	....	....	3–200	20–200	11–200
Schuyler	1,000–1,600	100–435	15–100	100–435	100–435	200–435
Yates	375–1,900					
Steuben	279– 850	....	25	....	50–100	....
Wyoming	1,500–2,000	140–200	100–200	200	50	125

WEST VIRGINIA.

As a producer of gas West Virginia took the lead in 1911, as in 1910. The State produced the enormous quantity of 207,112,576,000 cubic feet of gas, valued at $28,451,907, as compared with 190,705,869,000 cubic feet, valued at $23,816,553, in 1910.

Natural gas accompanies the oil wells of West Virginia even more regularly than in Pennsylvania, and the sands yielding gas without oil are more extensive, so that while the State consumed 80,868,645,000 cubic feet of gas in 1911, it also exported a large quantity to Pennsylvania, to the lake shore in Ohio, to Maryland, and to Kentucky. In order to supply the necessary quantity for Pittsburgh the gas is pumped through the lines at an average rate of 42 miles per hour, and occasionally at as great a speed as a mile a minute.

Exceptionally high gas pressures are still frequently found in the newer pools, though the decline in many localities has been marked in recent years. Drilling was active throughout the State in 1911, resulting in the completion of 870 productive gas wells out of a total of 987 wells drilled, the number of gas wells at the close of the year being 4,755 as compared with 4,052 wells at the beginning of the year. A total of 167 gas wells were abandoned in 1911.

The total quantity and value of the gas consumed in West Virginia in 1911 was greater than in 1910, amounting to 80,868,645,000 cubic feet, valued at $6,240,152, an average price of 7.72 cents per thousand cubic feet, as against 77,067,756,000 cubic feet, valued at $5,617,910, an average price of 7.16 cents in 1910. Of the total consumption in 1911 a larger proportion was consumed for industrial than for domestic purposes. In the quantity of gas consumed in manufacturing West Virginia is second, having consumed 50,130,046,000 cubic feet of gas.

One of the industries which is almost entirely confined to this State is the manufacture of carbon black, for which large quantities of gas are required and to which the gas is so well adapted. During the year 1911 it is estimated that a total of 18,737,265,000 cubic feet of gas was used by the carbon black factories of this State, the value of which was $544,856, an average of about 3 cents per thousand cubic feet. As much of this gas was consumed without being metered, these figures are only approximate.

During 1911 there were installed in this State several plants for the extraction of gasoline from casing-head gas, or gas from oil wells, much of which is allowed to waste. Some statistics regarding the production of natural-gas gasoline will be found on another page of this report.

Record of natural-gas industry in West Virginia, 1897–1911.

Year.	Gas produced.		Gas consumed.			Wells.		
	Number of producers.	Value.	Number of consumers.		Value.	Drilled.		Productive. Dec. 31.
			Domestic.	Industrial.		Gas.	Dry.	
1897	12	$912,528	[a]30,015	393	$791,192	47	1	196
1898	19	1,334,023	[a]28,652	125	914,969	32	4	227
1899	30	2,335,864	[a]38,137	305	1,310,675	78	6	300
1900	34	2,959,032	[a]45,943	184	1,530,378	129	6	428
1901	44	3,954,472	[a]55,808	266	2,244,758	177	8	604
1902	79	5,390,181	29,357	877	2,473,174	142	37	745
1903	88	6,882,359	36,179	1,122	3,125,061	242	43	987
1904	90	8,114,249	44,563	1,005	3,383,515	292	33	1,274
1905	76	10,075,804	45,588	1,417	3,586,608	385	28	1,579
1906	67	13,735,343	51,281	913	3,720,440	263	23	1,831
1907	105	16,670,962	53,807	1,000	[b]3,757,977	377	59	2,169
1908	138	14,837,130	63,228	1,225	[b]4,020,282	253	80	2,511
1909	183	17,538,565	70,853	1,907	[b]5,183,054	642	65	3,074
1910	241	23,816,553	86,778	2,659	[b]5,617,910	883	69	4,052
1911	340	28,451,907	87,438	1,566	[b]6,240,152	870	117	4,755

[a] Number of fires supplied.

[b] Includes gas consumed in Maryland.

Depth and gas pressure of wells in West Virginia, 1907–1911, by counties.

County.	Depth, in feet.	Pressure, in pounds.				
		1907	1908	1909	1910	1911
Braxton	2,100–3,000	250–900	250–500	240–525	125–535	840
Clay	1,600–2,000					200–400
Taylor	1,764–2,400					80–800
Brooke	1,200–1,800	100	30–600	100–600	100–400	0–50
Cabell	900–2,325	300–625	230–650	200–460	250–540	250–500
Calhoun	824–4,000	200–600	25–400	60–1,400	18–1,500	35–655
Doddridge	1,400–3,000	180–620	70–580	100–800	10–760	100–750
Gilmer	1,280–3,181	......	......	250–875	350–630	640
Hancock	700–1,400	15–300	1–220	10–150	3–100	1–60
Harrison	800–3,210	105–975	150–800	50–900	50–900	50–1,040
Kanawha	1,500–2,585	......	......	500	480–560	400–500
Lewis	1,510–3,000	250–900	275–750	200–720	125–800	60–950
Lincoln	1,100–2,720	500	585	250–450	400–500	400–650
Logan	1,200–1,205	......	......	......	......	......
Marion	1,500–3,400	300–350	100–700	125–580	50–600	90–[a]1,200
Marshall	1,000–2,900	......	160–300	200–300	10–295	50–300
Mingo	1,250–2,000	......	......	......	......	300–600
Wayne						
Monongalia	1,350–3,500	140–450	40–400	85–500	70–450	60–700
Nichols	1,200	......	......	......	......	40–125
Ohio	1,500–1,650	......	......	......	......	
Pocahontas	2,000–2,500	......	......	......	......	
Pleasants	900–2,001	50–300	200–350	100–250	100–150	150–400
Putnam	900–2,400	......	......	300–800	300–800	300–800
Upshur	2,000–2,800	......	......			25–740
Ritchie	900–2,200	......	25–670	45–670	20–800	250–275
Roane	1,472–2,350	340	500–700	400–500	275–600	
Tyler	1,650–2,700	160–550	40–340	65–300	35–440	50–100
Wetzel	2,000–3,560	125–242	65–300	95–250	70–300	0–200
Wirt	500–1,800	20–530	30–500	40–500	35–500	10–450
Wood	1,030–1,635	......	40–150	250–540	250–540	160–350

[a] Fifth sand well.

KENTUCKY.

In Kentucky much new capital is being invested in natural-gas developments. Until recently developments of this kind were allowed to go to waste. Since the Standard Oil Co. expended about half a million dollars in developing the Menifee County gas belt and in building a system of pipe lines to Lexington and other central Kentucky cities, a number of gas companies have conducted operations in eastern Kentucky, and more recently operations have been extended to fields in the western and northeastern sections. In southeastern Kentucky Pennsylvania operators have drilled numerous gas wells in Knox County and have built pipe lines to a number of points of consumption. The Wolfe County district has been more thoroughly developed and is now supplying two towns in eastern Kentucky with natural gas. Lately new companies have been organized to develop the gas fields of Warren and Webster counties, in western Kentucky. A gas system is being installed in the Webster County district, and the production of several recently drilled wells will be used in nearby towns. In Warren County rigs are up in the search for gas, and two good wells have already been drilled. Kentucky operators recently organized to develop a large area in the Big Sandy Valley, eastern Kentucky. A gas pipe line is proposed to connect several towns in that part of the State. In southeastern Kentucky Clay County is rich in natural gas, and a company has been organized to develop the field more thoroughly and utilize the product, much of which has been going to waste during the last five years. A large area has been developed in Fleming County, and, although no plans are now under way for utilizing the product, the output will eventually be piped to Kentucky cities and towns. About a dozen wells, all producers, have been drilled. A peculiar feature in this county not found in any other section is the total absence thus far of petroleum.

The total value of the gas produced in Kentucky in 1911 was $407,689, and the value of the gas consumed was $901,759, the difference representing the value of the gas piped from West Virginia, upon whose gas fields consumers in Kentucky are so largely dependent. The following towns are supplied with gas from West Virginia: Covington, West Covington, Newport, Bellevue, Ludlow, Mayville, Ashland, Catlettsburg, Louisa, Inez, Russell, Buchanan, Kinner, Warfield, and Kavanaugh.

The total number of productive gas wells in Kentucky at the close of 1911 was 252, of which 19 were completed during the year 1911. During the year 8 dry holes were drilled and 8 wells were abandoned.

Record of natural-gas industry in Kentucky, 1906–1911.

Year.	Gas produced.		Gas consumed.			Wells.		
	Number of producers.	Value.	Number of consumers.		Value.	Drilled.		Productive Dec. 31.
			Domestic.	Industrial.		Gas.	Dry.	
1906	45	$287,501	17,216	18	$287,501	......	......	1
1907	38	380,176	19,279	239	380,176	31	14	1
1908	38	424,271	21,778	42	424,271	19	23	2
1909	38	485,192	25,639	137	695,577	26	7	2
1910	47	456,293	27,961	112	908,293	23	12	2
1911	74	407,689	41,201	70	901,759	19	8	2

ALABAMA.

Considerable development work was done in Alabama in 1911 with the hope of finding an important oil or gas field, but the results have not been very encouraging. The Five Rivers Oil & Gas Co. is drilling in Fayette County, having reached a depth of 2,385 feet. The Providence Oil & Gas Co. has completed 5 gas wells in Fayette County, ranging in depth from 1,400 to 2,165 feet, with gas pressure of 500 to 540 pounds. This company is still drilling with the hope of increasing its supply. With the exception of gas used for drilling and a small quantity supplied to consumers in the town of Fayette, these wells have not been drawn upon. It is reported that the Sipsey Valley Oil & Gas Co. has completed a gas well in this field.

The New York-Alabama Oil Co. has 7 gas wells in Madison County, not all of which are being used. This company is drilling a deep well, having reached a depth of 2,400 feet. Gas from these wells is consumed for drilling operations; also to supply consumers in the town of West Huntsville.

The Pennsylvania Oil & Gas Co. is operating in Walker County. The Woodward Oil Co., prospecting in Winston County, has completed a gas well near Haleyville. No use is being made of the gas and the capacity of the well is unknown.

The number of productive gas wells in this State at the close of 1911 was 17, of which 4 were completed in 1911 and 5 abandoned. Eight dry holes were drilled in 1911.

The statistics of the production of natural gas in Alabama are included with those of Louisiana.

TENNESSEE.

The natural-gas situation remained the same in 1911 as in 1910. A small quantity of gas, valued at $300, was used for domestic purposes. The number of gas wells at the close of the year was 4, 1 having been abandoned in 1911.

During the year prospecting was active near Franklin and sufficient gas was obtained to justify piping the town.

OHIO.

Three natural-gas zones are recognized in Ohio, the distinctions being important, particularly as the great decline in the northwestern Ohio or "Trenton" has been compensated to a considerable extent by the rapid development of the Clinton or central Ohio field. The third field is associated with the light oil (Pennsylvania grade) of southeastern Ohio. The earliest of these fields to be developed was that of northwestern Ohio, where the gas, originally developed at Findlay, furnished the second important field in the industrial development, following the application of natural gas in manufacturing enterprises.

Gas was discovered in a Clinton sand at Lancaster, Ohio, in 1887, and further discoveries followed rapidly until this territory developed into one of the finest gas sands in the country. Further, the regularity of the sand led to comparatively easy prospecting. The rock structure is fairly simple. In the region of the Bremen field, Fairfield County, the dip is about 57 feet per mile, with occasional small rolls having a reverse dip. West of this region the sand thins and disappears before the longitude of the middle of the State is reached, its place being taken by shales. The great reservoirs of gas are usually found near the western margin of the sand, the oil existing at greater depths to the east.

The report shows that the year 1911 was one of the best in the history of the natural-gas business in Ohio. The central Ohio district, which comprises chiefly the counties of Licking, Knox, Hocking, Fairfield, and Ashland, was actively developed and extended northward into Lorain and Medina counties, many remarkable wells having been discovered, particularly in Ashland County, with an abundance of gas to supply the demands of consumers. At the close of the year many of the wells completed were closed in for future use. It is reported that the pressure in the older gas fields of this State is gradually being reduced. In the Homer field, including Knox and Licking counties, the average pressure decreased from 207 pounds in December, 1910, to 180 pounds in December, 1911; in the Sugar Grove field, including Fairfield and Hocking counties, the average pressure decreased from 125 pounds December, 1910, to 92 pounds, December, 1911; and in the new Ashland-Lorain field, including Ashland, Medina, Richland, Lorain, and Wayne counties, the average pressure increased from 663 pounds in December, 1910, to 770 pounds in December, 1911, owing to the opening of new territory.

As a consumer of gas in 1911, Ohio takes second place, having consumed 112,123,029,000 cubic feet, valued at $22,792,270, an average price of 20.33 cents per thousand cubic feet. It will be seen by reference to the table of distribution of gas, by States, that Ohio consumed more gas for domestic purposes than any other State in 1911, the total domestic consumption being 57,791,210,000 cubic feet, valued at $15,837,421, an average price of 27.40 cents, the number of domestic consumers supplied increasing from 475,505 in 1910 to 577,263 in 1911.

The total quantity of gas produced in this State in 1911 was 49,449,749,000 cubic feet, valued at $9,367,347, as compared with 48,232,406,000 cubic feet, valued at $8,626,954 in 1910. The difference between the quantity and value of the gas produced and consumed in this State shows the quantity and value of the gas piped into the State from West Virginia and Pennsylvania, the last-named State supplying only a small quantity.

The number of gas wells in this State at the close of 1911 remained the same as at the close of 1910, 450 gas wells having been completed and 450 gas wells abandoned during the year. The number of dry holes drilled in 1911 was 191.

Record of natural-gas industry in Ohio, 1897–1911.

Years.	Gas produced.		Gas consumed.			Wells.		
	Number of producers.	Value.	Number of consumers.		Value.	Drilled.		Productive Dec. 31.
			Domestic.	Industrial.		Gas.	Dry.	
897	157	$1,171,777	[a] 85,368	183	$1,506,454	88	51	729
898	237	1,488,308	[a] 68,211	349	2,250,706	120	12	806
899	359	1,866,271	[a] 77,787	691	3,207,286	134	17	929
900	281	2,178,234	[a] 135,743	1,092	3,823,209	97	19	990
901	305	2,147,215	[a] 149,709	949	4,119,059	113	35	1,099
902	451	2,355,458	120,127	786	4,785,766	266	40	1,343
903	515	4,479,040	197,710	1,786	7,200,867	290	62	1,523
904	453	5,315,564	232,557	1,136	9,393,843	334	49	1,661
905	425	5,721,462	274,585	2,955	10,396,633	342	58	1,705
906	409	7,145,809	310,175	3,316	12,652,520	337	51	[b] 1,977
907	468	8,718,562	380,489	5,476	15,227,780	431	90	2,942
908	[c] 970	8,244,835	427,276	3,621	15,166,434	398	124	[d] 3,691
909	[c] 1,534	9,966,938	450,973	5,260	18,884,312	548	149	[d] 4,260
910	[c] 1,630	8,626,954	475,505	3,187	21,210,965	466	202	[d] 4,717
911	[c] 1,900	9,367,347	577,263	3,634	22,792,270	450	191	4,717

[a] Number of fires supplied.

[b] Exclusive of complete report of shallow wells.

[c] Includes 735 producers in Ashtabula, Erie, Huron, Lake, Lorain, and Cuyahoga Counties having hallow wells for their own domestic purposes in 1908, 1,239 in 1909, 1,289 in 1910, and 1,476 in 1911.

[d] Includes 901 shallow wells located in Ashtabula, Erie, Huron, Lake, Lorain, and Cuyahoga Counties 1908, 1,568 in 1909, 1,541 in 1910, and 1,757 in 1911.

Depth and gas pressure of wells in Ohio, 1907–1911, by counties.

County.	Depth, in feet.	Pressure, in pounds.				
		1907	1908	1909	1910	1911
llen	1,200–1,300	200				
shland	2,575				[a] 663	670
shtabula	400–2,200		3– 300	5– 300	5–300	0– 275
thens	450–1,500	100	30– 250	160– 280	25–350	25– 350
uglaize	1,110–1,300	5– 250	5– 225		12– 30	2– 90
elmont	1,100–1,970	200– 275	5– 100	200– 300	60–600	40– 150
arroll	500–1,434	200– 375	200– 350	165– 300	185–350	90– 300
linton	715– 900					160– 190
ummit						
olumbiana	575–1,000	70– 240	30– 275	50– 287	55–240	25– 240
uyahoga	337–1,500		90	2– 100	2– 80	0– 97
arke	850–1,300	75– 103	30	5– 25	15–185	2– 250
rie	415– 650					20– 40
airfield	1,890–2,600	40– 130	5– 150	60– 500	50–280	40– 500
uernsey	1,000–1,311	400	300– 450	80– 400	50–300	350– 400
uskingum	800–3,350	400– 425	350– 400	1,000–1,100		
ancock	1,100–1,467	85	3– 5	2– 70	2– 50	0– 200
ardin	1,200–1,600		16– 150	25– 40	20–300	25– 300
arrison	685–1,630	40– 200	5– 125	5– 400	30–345	10– 110
ocking	2,300–3,300			800– 850		
uron	725– 800					10– 25
olmes	600–1,000	215	180– 205	225		135– 220
efferson	600–2,026	240	150– 495	40– 230	40–250	0– 400
nox	590–3,000	110– 400	140– 900	25– 400	80–390	50– 250
ake	360–1,560		100	1– 100	1–135	0– 165
icking	2,040–2,900	200– 750	100– 730	100– 750	80–600	60– 700
ogan	1,385–1,470	40		130– 280		
orain	338–2,590		0– 120	0– 840	0–500	[b] 1,150
ucas	1,165–1,550	1– 90	1– 80	8– 30	4– 11	5– 100
ahoning	650– 700					
edina	198–3,000		20– 75	10– 40	3– 30	5– 875
ercer	1,020–1,400	2– 40	2– 250	4– 210	1–150	3– 120
onroe	650–2,400	400	200– 500	25– 500	60–400	100– 400
organ	240–1,650	15– 500	20– 450	10– 400	20–450	20– 450
oble	484–2,000		550	150– 700	100–500	200– 650
ttawa	1,250–1,600	50– 420	20– 400	100– 350	200–450	85– 450
erry	650–3,448	350– 700	75– 85	50– 900	40–740	50– 250
ichland	1,950–2,800	1,100	500–1,000	450	250–400	150– 300
andusky	470–1,400	30– 75	20– 200	40– 160	5–175	5– 165
eneca	370–1,760	15– 140	2– 150	50– 175	25–100	25– 140
rumbull	370– 388		75			

[a] Average.

[b] New well.

Depth and gas pressure of wells in Ohio, 1907–1911, by counties—Continued.

County.	Depth, in feet.	Pressure, in pounds.				
		1907	1908	1909	1910	1911
Tuscarawas	850–1,100	....	....	....	325–385	260– 325
Van Wert	1,200–1,285	....	175	35	40	....
Vinton and Jackson	520– 800	300	275– 325	250	....	....
Warren	275–1,000	....	40– 50	....	....	....
Washington	500–2,600	75– 350	15– 550	15– 450	15–500	15– 500
Wood	1,175–1,500	20	....	....	20– 40	10– 15

INDIANA.

The large flat dome of the "Trenton" limestone extending over many counties of the eastern part of Indiana has been a prolific producer of gas in Indiana, but the reservoirs are more easily exhausted than in the Ohio portion of the field, and the yield for the State has declined to 4,365,339,000 cubic feet in 1911, compared with 5,760,252,000 cubic feet in 1910. Exhaustion of gas was general throughout the State in 1911. The Pike County gas field, which was the latest field discovered, proved a disappointment, several wells having been abandoned in 1911. The total number of domestic consumers supplied in the State declined from 36,054 in 1910 to 31,576 in 1911 and the number of industrial consumers from 282 to 143; the total value of the gas consumed in the State in 1911 amounted to $1,192,418 as compared with $1,473,403 in 1910.

The number of wells producing gas at the close of 1911 was 2,633, as compared with 2,955 at the beginning of the year. The number of productive gas wells completed in 1911 was 110 and the number of wells abandoned was 432.

It will be seen that the average price of gas per thousand cubic feet was slightly higher in 1911 than in 1910, advancing from 25.58 cents to 27.32 cents. The greater part of the gas produced in the State was consumed for domestic purposes, the gas supplied for industrial purposes being used chiefly for power.

Record of natural-gas industry in Indiana, 1897–1911.

Year.	Gas produced.		Gas consumed.			Wells.		
	Number of producers.	Value.	Number of consumers.		Value.	Drilled.		Productive Dec 31.
			Domestic.	Industrial.		Gas.	Dry.	
1897	452	$5,009,208	[a]214,750	935	$3,945,307	419	66	2,88
1898	533	5,060,969	[a]173,454	1,867	4,682,401	706	111	3,32
1899	571	6,680,370	[a]181,440	1,741	[b]5,833,370	838	109	3,9
1900	670	7,254,539	[a]181,751	2,751	[b]6,412,307	861	156	4,54
1901	656	6,954,566	[a]153,869	2,570	[b]6,276,119	985	208	4,57
1902	929	7,081,344	101,481	3,282	[b]6,710,080	1,331	205	5,8
1903	924	6,098,364	90,118	1,020	[b]5,915,367	895	242	5,51
1904	846	4,342,409	84,862	390	[b]4,282,409	706	153	4,6
1905	740	3,094,134	63,194	231	[b]3,056,634	252	74	3,6
1906	578	1,750,715	47,368	156	[b]1,750,755	159	46	3,5
1907	687	1,572,605	46,210	218	[b]1,570,605	185	56	3,3
1908	823	1,312,507	42,054	216	[b]1,312,507	187	41	3,2
1909	1,010	1,616,903	40,565	369	[b]1,616,903	190	70	2,9
1910	1,027	1,473,403	36,054	282	[b]1,473,403	69	33	2,9
1911	1,094	1,192,418	31,576	143	[b]1,192,418	110	32	2,6

[a] Number of fires supplied.

[b] Includes value of gas consumed in Chicago, Ill.

Depth and gas pressure of wells in Indiana, 1907–1911, by counties.

County.	Depth, in feet.	Pressure, in pounds.				
		1907	1908	1909	1910	1911
dams	1,000–1,050	....	....	250	....	....
artholomew	864– 990	5– 150	100–150	50–175	50–250	150–175
lackford	850–1,100	1– 65	2– 60	1– 25	1– 10	0– 30
ark	128– 244	....	10– 27	....	....	....
aviess artin	400– 600	8– 25	5– 50	0– 20	0– 60	9–160
ecatur	725–1,200	15– 335	10–335	0–325	0–315	0–325
elaware	728–1,500	1– 40	1– 75	1– 55	0– 70	0– 75
rant	830–1,200	[a]0–[b]240	45	2– 45	2– 50	0–180
amilton	800–1,200	10– 175	10–190	5–185	15–180	15–225
ancock	700–1,100	5– 140	5–250	0–100	0–100	3–280
arrison	320– 764	60	40	....	....	60–110
enry	800–1,100	15– 120	5–270	5–100	0– 90	0– 80
oward	850–1,100	25– 250	3–240	0–200	0–220	20–250
y	900–1,417	160	60	0– 50	0– 40	0–110
fferson	1,360	....	8– 10	....	....	10
adison	800–1,200	1– 200	1–150	0–200	0–190	0–180
iami	900–1,000	20– 60	20–100	0– 10	0– 40	....
arion ipley	900–1,050	60– 190	....	35	40	180–285
ike	1,000–1,400	....	250–525	300–550	125–500	100–480
andolph	900–1,300	5– 260	1–220	0–175	0–180	2–300
ush	700–1,400	25– 350	10–350	9–375	20–325	0–300
elby	750–1,000	45– 350	25–330	10–310	1–375	1–300
ullivan	698– 750	295	295	250	200	50–100
ipton	750–1,100	40– 200	10–180	18–180	10–230	15–190
ayne	800–1,150	50– 80	50–250	20–300	50–240	25–150

[a] Run on vacuum. [b] New.

ILLINOIS.

Illinois is essentially an oil producer, and gas is a minor by-product, till the quantity produced shows a slight increase, and it must be orne in mind that much territory remains to be explored which is avorable for gas as well as for oil.

Although natural gas is more widespread than oil in Illinois, the vailable quantity is small in any given locality. Many houses and ven small industrial establishments are supplied in the State, but he total production is light.

The quantity and value of the natural gas produced in Illinois was lightly greater in 1911 than in 1910, there being an increase from ,723,286,000 cubic feet, valued at $613,642, to 6,751,581,000 cubic eet, valued at $687,726, a gain of 28,295,000 cubic feet in output nd of $74,084 in value. In the table showing distribution of gas y States it will be seen that the quantity of gas supplied for domestic urposes in Illinois declined from 1,266,057,000 cubic feet in 1910 to ,252,872,000 cubic feet in 1911, and that the value of the product ncreased from $278,377 in 1910 to $288,802 in 1911. On the other and, the estimated quantity of gas supplied for industrial purposes n 1911 increased in both quantity and value over that of 1910. Gas onsumed for industrial purposes was principally used for power in he oil fields.

The average value of gas per thousand cubic feet was higher in 911 than in 1910, the price of gas for domestic consumption advancing from 21.9 cents in 1910 to 23.05 cents in 1911 and for industrial onsumption from 6.1 cents in 1910 to 7.25 cents in 1911, the average rice for all gas consumed in the State being 9.13 in 1910 and 10.19 n 1911.

The same cities and towns supplied with gas in this State in 1910 were supplied in 1911. No important gas fields were discovered since our last report. A few small wells were drilled in Morgan County, the product of which was piped to Jacksonville and supplied for producing power in 1911. The counties from which gas was produced and used in Illinois in 1911 were as follows: Bond, Bureau, Champaign, Clark, Crawford, Cumberland, Dewitt, Edgar, Lawrence, Lee, Logan, McHenry, McLean, Macoupin, Morgan, and Pike.

The number of gas wells remained the same at the close of the year 1911 as at the beginning of the year, 69 gas wells having been drilled and 69 gas wells abandoned. A total of 78 dry holes was drilled in 1911.

Record of natural-gas industry in Illinois, 1906–1911.

Year.	Gas produced.		Gas consumed.			Wells.		
	Number of producers.	Value.	Number of consumers.		Value.	Drilled.		Productive Dec. 31.
			Domestic.	Industrial.		Gas.	Dry.	
1906	66	$87,211	1,429	2	$87,211	......	......	200
1907	128	143,577	2,126	61	143,577	94	41	283
1908	185	446,077	[a] 7,377	[a] 204	[a] 446,077	121	42	400
1909	194	644,401	[a] 8,458	[a] 518	[a] 644,401	56	11	423
1910	207	613,642	[a] 10,109	[a] 261	[a] 613,642	64	31	458
1911	225	687,726	[a] 10,078	[a] 293	[a] 687,726	69	78	458

[a] Includes number of consumers and value of gas consumed in Vincennes, Ind.

Depth and gas pressure of wells in Illinois, 1908–1911, by counties.

County.	Depth in feet.	Pressure, in pounds.			
		1908	1909	1910	1911
Bond	929–1,680	500–600	200–580	200–750	100–350
Lawrence					
Bureau	98– 357	0– 30	0– 23	0– 23	0– 42
Champaign	80– 130	....	....	15– 32	15– 30
Clark	250– 550	65–100	38–100	35– 45	10– 60
Crawford	500–1,550	25–400	45–275	20–225	10–150
Cumberland	500– 575	15– 35	40	....	....
Dewitt	94– 127	....	....	25– 50	20– 50
Edgar	260– 600	....	....	75–127	50– 90
Lee	126– 280	....	....	18– 28	19– 28
Logan	84– 90	....	....	....	....
McHenry	160– 372	....	....	....	10– 22
McLean					
Macoupin					
Morgan	260– 400	....	....	....	100
Pike	96– 333	3– 10	3– 7	4– 10	4– 20

KANSAS.

The State of Kansas, which occupied third place in the quantity of gas produced in the years 1909 and 1910 and fourth place in the value of the gas produced in each of these years, dropped to fifth place in both quantity and value of its gas production in 1911. The total quantity of gas produced in Kansas amounted to 38,799,406,000 cubic feet, valued at $4,854,534, in 1911, as compared with 59,380,157,000 cubic feet, valued at $7,755,367, in 1910, a decrease of 20,580,751,000 cubic feet in quantity and of $2,900,833 in value. This reduction was due to the exhaustion of the gas, there being a decline in both pressure and volume of wells in many of the gas fields of the State. By reference to the table giving a record of wells it will be seen that 446 gas wells were abandoned in this State in 1911, and that the number of productive gas wells at the close of 1911 was 2,004 as against 2,149 wells at the close of 1910. Although no new gas fields were reported for Kansas in 1911, considerable development work was accomplished in the old fields of the State, resulting in the discovery of some very good wells, a total of 301 productive gas wells having been completed in 1911.

As to the quantity of gas consumed, Kansas and Missouri[1] dropped from third place in 1910 to fourth place in 1911, although the value of the gas consumed was greater, making this State advance to third place in value of gas consumed in 1911. The total gas consumption amounted to 77,861,143,000 cubic feet, valued at $9,493,701 in 1911, as compared with 83,340,045,000 cubic feet, valued at $9,335,027, in 1910, a decrease of 5,478,902,000 cubic feet in quantity and an increase of $158,680 in value. The difference between the quantity and the value of the gas produced and consumed was 39,061,737,000 cubic feet and $4,639,167, which represents the quantity and value of the gas piped into Kansas and Missouri by the various pipe-line systems from the gas fields of Oklahoma upon which consumers in these States are so largely dependent for their supply of gas. The quantity of gas piped from Oklahoma to each of these States could not be determined. This gas was chiefly drawn from wells in Nowata, Rogers, and Washington counties, Okla., and was supplied to consumers in Kansas and Missouri for both domestic and industrial purposes.

On reference to the table showing the distribution of gas to consumers in 1911, it will be observed that a little over one-third of the gas con-consumed in Kansas and Missouri was supplied for domestic purposes, or 27,688,371,000 cubic feet, valued at $6,317,307, the remainder, 50,172,772,000 cubic feet, valued at $3,176,394, being supplied for industrial purposes, of which 46,570,417,000 cubic feet, valued at $2,849,626, was consumed for manufactures and 3,602,355,000 cubic feet, valued at $326,768, consumed for other industrial or power purposes. It will be seen that the value of the gas consumed in domestic use in these States in 1911 was almost twice as great as the value of the gas consumed for industrial uses.

The gas consumed in the State of Kansas in 1911 for manufacturing purposes, as in previous years, was largely used at zinc, cement, brick, and glass works, and the following statement regarding its consumption may be of interest:

The estimated consumption of gas at cement plants in Kansas in 1911 was 13,272,417,000 cubic feet, valued at $729,911, an average price of 5.5 cents per thousand cubic feet. The plants supplied were those of Ash Grove Lime & Portland Cement Co., Iola Portland Cement Co., Monarch Portland Cement Co., Altoona Portland Cement Co., Chanute Cement Co., United Kansas Portland Cement Co., and United States Portland Cement Co.

There was supplied to zinc smelters in Kansas in 1911 an estimated quantity of 13,186,505,000 cubic feet of gas, valued at $543,301, an average price of 4.12 cents per thousand cubic feet, the price ranging from 1 to 7½ cents per thousand cubic feet. This gas was supplied to two plants of the Prime Western Spelter Co. at Gas City and East Iola, two plants of Kansas Zinc Co. at La Harpe and Altoona, two plants of American Zinc, Lead & Smelting Co. at Caney and Dearing, the plant of Edgar Zinc Co., the plant of Chanute Zinc Co., and the plant of Granby Mining & Smelting Co.

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[1] Statistics of production and value of gas piped from Oklahoma and Kansas into Missouri are included with those of Kansas.

There was also supplied to brick and glass works in Kansas in 1911 an estimate of 3,594,287,000 cubic feet of gas, valued at $191,140, an average of 5.3 cents per thousand cubic feet, the price ranging from 3 to 9 cents.

The difficulty in supplying the demands of Kansas City during the winter of 1910–11 caused the municipal government of the city to undertake an investigation of the natural-gas supply, and Erasmus Haworth, State geologist of Kansas, was commissioned to investigate the probable duration of the supply for Kansas City; his report brought the condition of affairs sharply before the public by the forecast that the supply would become inadequate within three or four years.

The distribution of the districts which are productive at present is shown in the tables which follow, together with statistics of depth and pressures of wells. This represents the present condition, but sight should not be lost of the possibility of finding gas farther to the west, conformably to the recent discoveries of oil and gas to the west of the general development in Kay County, Okla.

In connection with the decreased production in Kansas, the curves in figures 1 and 2 show the recorded decline in pressures at frequent intervals for large groups of wells in each important field in Kansas and Oklahoma. The similarity in the rate of decline of the pressures is striking, as shown by the form of the curves. The flattening of the curves as pressures below 100 pounds are reached is encouraging and is consistent with experience with the long-lived wells in Pennsylvania and New York.

Record of natural-gas industry in Kansas, 1897–1911.

Year.	Gas produced.		Gas consumed.			Wells.		
	Number of producers.	Value.	Number of consumers.		Value.	Drilled.		Productive Dec. 31.
			Domestic.	Industrial.		Gas.	Dry.	
1897	10	$105,700	[a]3,956	20	$105,700	16	8	90
1898	29	174,640	[a]6,186	44	174,640	34	18	121
1899	31	332,592	[a]10,071	71	332,592	44	22	160
1900	32	356,900	[a]9,703	65	356,900	54	15	209
1901	48	659,173	[a]10,227	72	659,173	71	35	276
1902	80	824,431	13,488	91	824,431	144	63	404
1903	120	1,123,849	15,918	143	1,123,849	295	66	666
1904	190	1,517,643	27,204	298	1,517,643	378	135	1,029
1905	171	2,261,836	46,852	601	2,265,945	340	157	1,142
1906	130	4,010,986	79,270	990	[b]4,023,566	331	99	1,495
1907	196	6,198,583	149,327	1,605	[b]6,208,862	361	163	1,760
1908	212	7,691,587	168,855	1,162	[b]7,691,587	403	208	1,917
1909	199	8,293,846	182,657	1,160	[b]8,356,076	452	214	2,138
1910	204	7,755,367	186,333	1,412	[c]9,335,027	392	195	2,149
1911	232	4,854,534	199,523	907	[c]9,493,701	301	152	2,004

[a] Number of fires supplied.

[b] Includes gas taken from Kansas and consumed in Missouri.

[c] Includes gas taken from Kansas to Missouri; also gas piped from Oklahoma to Kansas and Missouri.

Depth and gas pressure of wells in Kansas, 1907–1911, by counties.

County.	Depth, in feet.	Pressure, in pounds.				
		1907	1908	1909	1910	1911
Allen	600–1,300	10–300	5–300	5–300	15–350	5–351
Anderson	230– 770	43–200	65–237	65–200	40–150	60–225
Bourbon	200– 710	50	50	75	35– 45	....
Chase	80–1,100	48–100	6–150	17–300	10–350	1–400
Crawford Cowley	150– 800	25–150	20– 26	55– 80	4– 65	20– 40
Chautauqua	300–1,300	50–280	50–260	60–500	40–500	25–250
Douglas Johnson	130– 870	60–230	5–170	40–180	10–100	30–120
Elk	500–1,278	10–300	100–215	40–200	100–225	100–225
Butler Greenwood Woodson	365–1,450	75–450	40–640	40–500	40–550	65–450
Labette	350–1,000	80–200	80–208	60–125	50–160	25–235
Linn	150– 750	9–175	10–175	10–150	12–130	22–110
Franklin Miami	160– 750	20–225	20–260	20–200	75–210	50–220
Montgomery	258–1,600	25–530	40–530	10–350	3–295	5–350
Neosho	490–1,200	40–225	50–250	25–350	35–300	20–287
Wilson	250–1,300	70–395	50–395	25–400	12–400	20–380
Wyandotte	271– 675	175	160–198	150–250	50–200	40–250

MISSOURI.

The production of gas in Missouri is of little importance. This State is supplied with gas chiefly from the fields of Oklahoma and Kansas. The gas wells of Missouri are located in Bates, Cass, and Jackson counties. With the exception of the town of Rich Hill, all of the gas produced in Bates County is consumed by the owners of the wells for their own purposes. Consumers in the town of Belton are supplied with gas from wells in Cass County. Domestic consumers in Martin City are supplied with gas from wells in Jackson County, and there are a few wells in this county the product of which is chiefly used for power by the owners of the wells. A number of domestic consumers in Jackson County are being supplied with gas from oil wells.

The total number of gas wells at the close of the year 1911 was 60, of which 15 were drilled in 1911. A total of 5 dry holes was drilled, and 9 wells were abandoned in 1911.

The total value of the gas produced in Missouri and supplied for consumption in 1911 was $10,496.

OKLAHOMA.

In Oklahoma the production of oil is complicated by high gas pressures to a greater extent than in most other oil fields. This pressure has offered many obstacles to the ordinary course of oil production, and the resulting situation has led to much waste of natural gas and to many-sided complications between the oil and the gas producers, the landowners and the State and Federal authorities.

In addition to this immediate association of oil and gas in the same well, there are also large accumulations of gas in pools, which at present yield gas alone. This gas is largely exported to Kansas. The gas in the Hogshooter district is chiefly utilized in this way, but the supplies in Nowata, Okmulgee, and Tulsa counties are also large. So long as more gas can be supplied from these gas sands than the market can use, it is natural that little attention should be paid by the gas companies to buying up the smaller supplies which are wasted from the oil wells.

The principal difference between the oil and the gas industries in respect to a cash market lies in the inability of purchasers to store gas under the simple conditions that prevail in the oil industry. It is true that large quantities of gas could be stored under high pressure in fairly small space, and large quantities are daily being obtained in

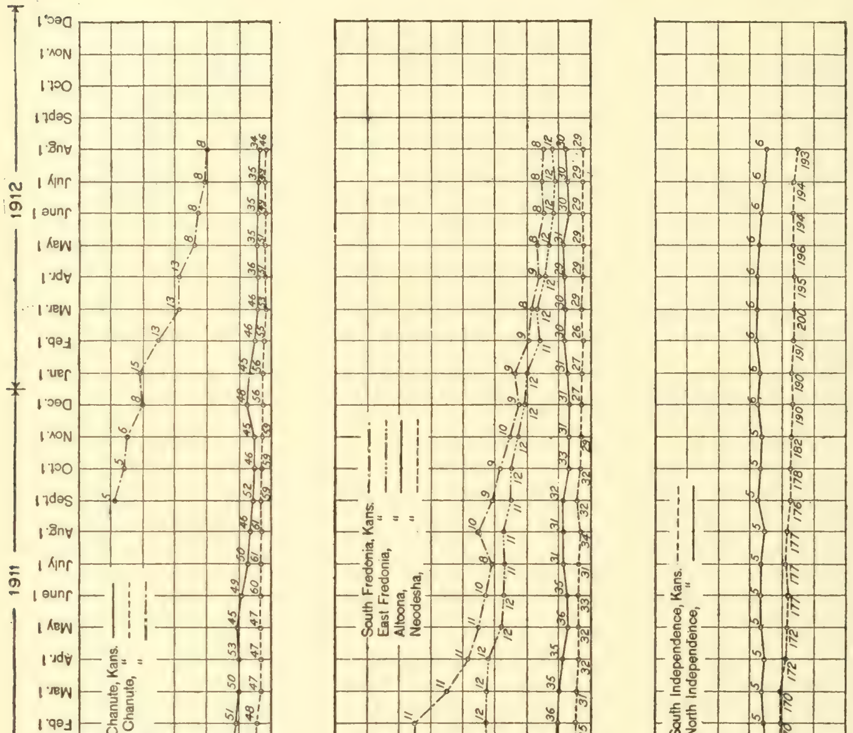

FIGURE 4.—Curve showing rate of decline in pressure in the natural-gas fields of Kansas.

the course of extracting gasoline from natural gas, but aside from the cost of the extra receptacles required in addition to those used in the pressure gasoline plants, this high pressure is costly to produce. If pressure could be utilized again as propelling power in transporting the gas from the field to a market, it should be theoretically possible to convert the pressure into useful work. This would be practically true if there were no time limit, but the rapidity with which the gas must be transported causes this high pressure to be largely wasted.

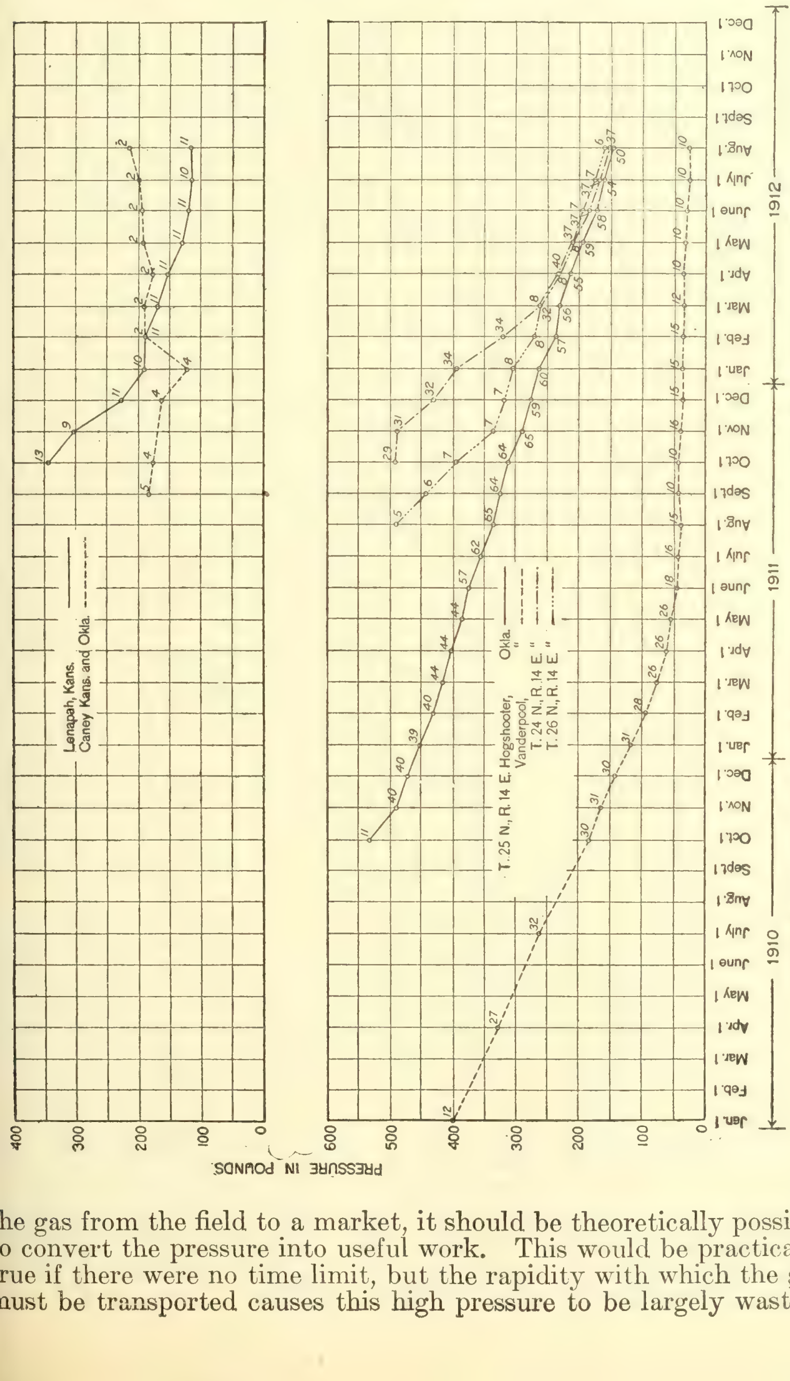

FIGURE 5.—Curve showing rate of decline in pressure in the natural-gas fields of Oklahoma and Kansas.

First, the energy of heat of compression is wasted by cooling the gases and then when the pressure is relieved in converting it into propelling force the resultant low temperatures can not be corrected by gradual absorption of heat from surrounding bodies on account of the rapidity necessary in taking the large quantities to the delivery points. It is suggested that eventually the gas can be stored economically in solvents as carbonic-acid gas is dissolved in water under pressure, or as acetyline gas is now supplied dissolved in acetone. The extent to which gas will dissolve under different pressures in various oil products, will be a fruitful field of investigation.

Reports received from Oklahoma indicate that the year 1911 was the greatest in the gas industry of this State. The pipe-line systems having lines extending into the gas fields of Nowata, Rogers, and Washington counties piped more gas out of the State to consumers in Kansas and Missouri in 1911 than in 1910, and the natural-gas companies distributing gas to consumers within the State increased their supply. The total estimated production of natural gas in Oklahoma in 1911 amounted to 67,275,608,000 cubic feet, valued at $6,731,770, an average price of 10.01 cents per thousand cubic feet, as compared with 50,429,646,000 cubic feet, valued at $3,490,704 in 1910, an average price of 6.92 cents per thousand cubic feet, a gain of 16,845,962,000 cubic feet in quantity and of $3,241,066 in value. This increase in value was caused by the increasing demand for gas for domestic purposes to supply consumers in Kansas and Missouri, the value given being the price received for the gas at the point of consumption in those States. Of the total production reported, 28,213,871,000 cubic feet, valued at $2,092,603, was supplied to 44,854 domestic and 1,507 industrial consumers within the State, while 39,061,737,000 cubic feet, valued at $4,639,167, or nearly 60 per cent of the total product and nearly 70 per cent of the total value, was supplied to consumers in Kansas and Missouri.

It will be seen from the table showing distribution of gas by States that of the total gas consumption of Oklahoma 5,816,723,000 cubic feet, valued at $981,976, an average of 16.88 cents per thousand cubic feet, was supplied for domestic purposes, and that 22,397,148000 cubic feet, valued at $1,110,627, an average price of 4.96 cents per thousand cubic feet, was utilized for industrial purposes, the quantity consumed for industrial purposes being nearly four times as great as the quantity consumed for domestic purposes.

During the year 1911 there was an approximate consumption of 6,544,365,000 cubic feet of gas, valued at about $160,000, or 2½ cents per thousand cubic feet, in Oklahoma for zinc smelting and cement works, and about 1,536,216,000 cubic feet, vauled at $57,500, or 3¾ cents per thousand cubic feet, for brick manufacture. One item of interest is the establishment of a factory for the manufacture of carbon black at Coalton, Okla., the first works of this kind in the State.

A considerable quantity of gas was produced from the oil wells of this State and used for development or field purposes, also for the manufacture of gasoline, several plants having been installed for this purpose to use the waste or surplus gas from oil wells, the statistics of which will be found in another part of this report. Notwithstanding the large consumption and demands for gas there are a number of wells closed in this State awaiting a market.

During 1911 the number of gas wells increased from 509 on January 1 to 718 on December 31, the productive wells drilled during the year numbering 303, and 94 gas wells being abandoned.

Record of natural-gas industry in Oklahoma, 1906-1911.

Year.	Gas produced.		Gas consumed.			Wells.		
	Number of producers.	Value.	Number of consumers.		Value.	Drilled.		Productive Dec. 31.
			Domestic.	Industrial.		Gas.	Dry.	
1906	50	$259,862	8,391	202	$247,282	81	33	239
1907	107	417,221	11,038	277	406,942	99	41	[a]344
1908	115	860,159	17,567	356	860,159	73	40	[b]374
1909	131	1,806,193	32,907	1,527	1,743,963	97	35	454
1910	168	3,490,704	38,617	1,557	1,911,044	93	58	509
1911	204	6,731,770	44,854	1,507	2,092,603	303	143	718

[a] Includes 87 wells "shut in" in 1907.

[b] Includes 100 wells "shut in" in 1908.

Depth and gas pressure of wells in Oklahoma, 1908–1911, by counties.

County.	Depth, in feet.	Pressure, in pounds.			
		1908	1909	1910	1911
Carter	590–1,040	190–200	50–350	60–100	48–150
Cherokee	600– 650				
Comanche	380– 400				
Craig	500	....	....	....	40–470
Latimer	1,575				
Sequoyah	1,200				
Creek	400–2,500	60–900	50–900	40–450	20–700
Kay	436–1,020	75–481	60–385	60–375	40–390
Kiowa	350– 825	50–150	....	35	10– 50
Leflore	1,300–1,866	....	....	350	300–355
Muskogee	1,055–1,910	470–650	130–160	50–500	18–225
Nowata	450–1,700	100–450	120–500	70–100	60–450
Okmulgee	760–2,180	300–800	150–700	150–800	100–700
Osage	900–2,010	300–850	300–850	200–650	150-650
Pawnee	1,200–2,075	200–400	160–260	150–200	200–450
Rogers	380–1,250	110–320	50–550	125–530	90–480
Tulsa	580–1,742	50–700	50–700	50–650	80–400
Wagoner	750–1,700	350–600	210–600	90–120	100–300
Washington	453–2,260	40–700	60–800	80–740	15–620

LOUISIANA.

The natural gas supply in Caddo Parish still remains one of the largest known. Its limits have been extended somewhat north and west in the course of the oil developments in this erratic region.

During 1911 one of the two wild gas wells was closed, or rather "killed"—that is, stopped up by mud. As described by Mr. S. S. Hunter, who originally owned this well, the "killing" was effected without great difficulty by drilling another well as near as possible to the rim of the crater of the old wild well. The new well had a diameter of 8 inches, and was drilled to the top of the gas sand. A large pump was then used, which gave a pressure greater than the pressure of the gas, and by it mud and water were pumped into the well for about three weeks, and at the same time mud and water were pumped into the crater of the old well. The mud and water finally found their way into the gas sand and in that way choked off the gas. At times this old crater shows the escape of gas and, if allowed to stand for some time without pumping some water into the 8-inch well, it might become unmanageable again.

The wild gas well to the east of the railroad at Oil City is still uncontrolled. The only change in the last year is that the crater has increased to about two or three times the area that it had during the year after the first outbreak. It still has a great deal of pressure, and when it takes fire the waves roll out of the sides in solid sheets of flame.

The event of chief interest in Louisiana during 1911 was the exploratory work for oil at several points in the neighborhood of Mansfield, De Soto Parish. In January the Spider Oil Co. began a second test, after leasing a large territory. Gas was struck in this test at 800 feet and again at 900 feet. By February 9 the Gulf, Producers, and Trees companies were also drilling, and found gas at 1,500 feet. Finally, by September, heavy gas pressures in sands sufficiently thick to justify considerable production were found at from 1,500 to 1,600 feet, and the existence of a new gas field was assured. In February the Christian Oil Co. began drilling in the neighborhood of Natorton. By July 20 three gas sands had been penetrated in its second test, which at that date reached 1,800 feet. In August, the second test reached 2,450 feet, and it was planned to drill 50 feet deeper, and if no further large supply of gas was obtained to abandon the test, although the showings of gas at comparatively shallow depths assured a moderate supply. Late in September, when the drill reached 2,600 feet, gas was struck, giving an estimated supply of 15,000,000 cubic feet of gas per day. Other companies, including the Henry Oil Co. and S. A. Guy, have also begun operations. These results have been sufficient to excite general interest in the exploration of the entire region between Shreveport and Alexandria and as far east as Monroe, in the hope of developing further oil and gas fields.

Early in the year 1912 a well drilled for water in the fairgrounds by the town of Shreveport struck high pressure of gas. Though the well proved to be so difficult to control as to yield little profit itself, it has naturally stimulated drilling in the hope of a large supply of gas directly in the town of Shreveport, and four or five small gas wells have since been developed.

Of greater significance to the utilization of Louisiana natural gas has been the extension of a pipe line from the Caddo field to various towns to the northeast, including Little Rock, Ark. This will afford a much-needed market and a stimulus to the conservation of the entire supply.

The State of Louisiana continues to increase its gas production. During the year 1911 a total of 36 gas wells were completed and only 1 gas well was abandoned. Many of these wells are closed in, there being no market for the product. Gas wells have been discovered in Caddo, De Soto, and Lafourche Parishes. So much has been written about the Caddo field in previous reports that little can be added. In the new gas field of De Soto Parish there are five gas wells not more than a year old which show no reduction of pressure. The thickness of the sands is from 60 to 130 feet between cap rock and bottom of sand, and the depth of wells ranges from 810 to 2,250 feet. By test the gas contains no gasoline, but is an excellent gas for commercial purposes, domestic and industrial consumers in the town of Mansfield being supplied with gas from this field. One well is in process of drilling in this field. In Natchitoches Parish one well is in course of drilling. Gas was struck at a depth of 1,120 feet, and the well was cased off and drilled deeper. During the year 1911 three wells drilled in Calcasieu Parish showed the presence of gas, but not in commercial quantities. The latest news from this State is the drilling of a large gas well at the State fairgrounds, inside the city limits of Shreveport, and borings were being made for salt water to supply a natatorium. The well is said to have a capacity of 6,000,000 cubic feet and 400 pounds rock pressure—a dry gas well.

In the fall of 1911 the Arkansas Natural Gas Co. began to supply consumers in Arkansas with gas from the Caddo field, and the towns of Hope, Prescott, Arkadelphia, Malvern, and Benton were supplied. Much of the gas produced in the Caddo field is piped to Texas and consumed in the towns of Atlanta, Queen City, Marshall, Texarkana, and Texarkana, Ark. On account of the confidential nature of the reports, it is not possible to publish the quantity and value of the gas produced in Louisiana and consumed outside of the State. The towns supplied with gas in Louisiana are Shreveport, Mooringsport, Blanchard, Caddo, Rodesso, Oil City, Vivian, Bloomburg, Ravenna, Dixie, Belcher, and Mansfield.

The total quantity of gas produced from wells in Louisiana and Alabama in the year 1911 was 9,786,041,000 cubic feet, valued at $858,145.

TEXAS.

The principal supply of natural gas from this State continues to come from the Henrietta or Petrolia field of Clay County on the northern edge of the State. The principal operators in northern Texas are the Lone Star Gas Co. and the North Texas Gas Co., both of which have large production and are supplying gas for consumption. Two distributing companies which purchase gas from the Clay County field to supply consumers are the Fort Worth Gas Co., which is supplying Fort Worth, and the Dallas Gas Co., which is supplying Dallas. In addition to these two cities gas is supplied from wells in the Clay and Navarro County gas fields to consumers in the following-named cities and towns: Corsicana, Wichita Falls, Petrolia, Henrietta, Byers, Bowie, Decatur, Alvord, Rhome, Sunset, Bridgeport, Irving, and Bellevue, and preparations are being made to supply Gainesville, Denton, Whitesboro, Denison, and Sherman.

The total production of gas in Texas in 1911 is estimated at 5,503,393,000 cubic feet, valued at $1,014,945, the average price being 18.44 cents per thousand cubic feet. It will be seen that the total distribution to domestic consumers amounted to 1,590,858,000 cubic feet, valued at $631,986, the remainder of the gas, 3,912,535,000 cubic feet, being supplied for industrial consumption, including gas used for manufacturing and for power. The average price received for gas supplied for industrial purposes was 9.79 cents per thousand cubic feet.

The number of domestic consumers supplied in the State in 1911 was 22,972 and the number of industrial consumers 303.

The total number of gas wells in Texas at the close of 1911 was 68, of which 19 were drilled in 1911. A total of 14 dry holes was drilled in 1911 and 3 gas wells were abandoned.

Considerable development work was under way in Texas in 1911. It is interesting to report that gas production from wells in Shackelford County was being supplied to domestic and industrial consumers in the town of Moran. Work in this county is still in the development stage, wells now being bored in the vicinity of the completed wells. In Webb County several gas wells were completed, the product of which was used for drilling in the field and supplied for domestic and industrial consumption in the town of Laredo. In Coleman and Brown counties attempts are being made to develop an oil or gas field. Five wells are being drilled on top of Holloway Mountain, showing some oil and gas, but not yet in paying quantities. Some drilling is being done near Trickham, which resulted in the discovery of a gas well of 350 pounds pressure and 3,000,000 cubic feet capacity, the product of which was used in 1911 only for drilling. In McMullen County sufficient gas was produced from one oil well to supply a few domestic consumers in the town of Crowther. It is reported that a gas well was completed in Maverick County, but no further information was obtained concerning this development.

The following is an analysis of Clay County gas, made by the United Gas Improvement Co., of Philadelphia, Pa.:

Analysis of natural gas from Dallas Gas Co., Texas.

[Sample received Sept. 9, 1909; C. C. Tutwiler, analyst.]

Illuminants	0.3
Carbonic oxide	0
Hydrogen	.8
Marsh gas	47.2
Ethane	12.5
Carbonic acid	.2
Oxygen	.4
Nitrogen	38.6
	100.0

CALIFORNIA.

As indicated in the report for 1910, the development of natural gas in several localities in California, especially in the Buena Vista Hills, has proceeded rapidly in the hands of large corporations, resulting in a supply of natural gas to the town of Bakersfield and to other points in the San Joaquin Valley, with the prospect of ultimate extension to Los Angeles. During the year, several gas wells, among them perhaps the largest ever drilled in the United States, were opened with convincing evidence from the pressure and the thickness of the sands of an adequate supply justifying large development.

The estimated value of natural gas consumed in California in 1911 was $800,714, as compared with $476,697 in 1910, a gain of $324,017, or nearly 70 per cent, it being the greatest year in the history of the natural-gas industry in this State. This was the result of increased production and distribution of gas to consumers from wells in the Midway field, pipe lines for which were in course of construction in 1910. In the early part of 1911 Bakersfield was being supplied with gas from this field, in addition to Maricopa, Taft, and Fellows, besides camps and drilling rigs in the Kern County oil fields. No new gas fields were opened in this State in 1911, but a total of 8 productive gas wells was completed, all of which were located in the Midway field, the number of gas wells in this field being 12 at the close of the year 1911. The indications are that there is a large quantity of gas now available and the probability of a continued supply. It is reported that additional gas lines may be extended from this field, one of which will supply domestic consumers in Los Angeles and other towns adjacent.

By referring to the table of distribution of gas in 1911, by States, it will be seen that the total distribution of gas to 10,598 domestic consumers in California was 543,392,000 cubic feet, valued at $317,467, as against 245,738,000 cubic feet of gas, valued at $194,631, supplied to 8,292 domestic consumers in 1910. The quantity and value of the gas supplied for industrial purposes in this State in 1911 was estimated to be 5,846,428,000 cubic feet, valued at $483,247, which was principally consumed for power in the oil fields. However, considerable quantities of gas are daily wasted, and for the purpose of utilizing this surplus gas some plants for the production of gasoline are being installed in the oil fields of Brea Canyon, Puente, and Santa Maria.

The principal towns supplied with gas in California are as follows: Stockton, with gas from San Joaquin County; Sacramento, with gas from Sacramento County; Ventura, Oxnard, and Santa Paula, with gas from Ventura County; Suisun City, Fairfield, and Cement, with gas from Solano County; Santa Maria, Guadalupe, and Betteravia, with gas from Santa Barbara County; and Bakersfield, Maricopa, Taft, and Fellows, with gas from Kern County.

The total number of wells from which gas was being used at the close of 1911 was 60 as compared with 54 at the close of 1910. During the year 8 productive gas wells were drilled and 6 dry holes and 2 gas wells were abandoned.

ARKANSAS.

The condition of the natural-gas industry in Arkansas was practically the same in 1911 as in 1910. No new developments have been reported. Most of the gas produced in the State is drawn from wells in Sebastian County, although there is a small production from wells in Scott County. The cities of Fort Smith, Mansfield, and Van Buren are supplied from this source.

During the year 1911 the Arkansas Natural Gas Co. began to supply consumers in the State with gas from the Louisiana gas field, distributing gas to the towns of Hope, Prescott, Arkadelphia, Malvern, and Benton.

Five productive gas wells were completed in Sebastian County, two dry holes were drilled, and one gas well was abandoned in 1911.

The statistics of the natural-gas industry of this State are included with those of Colorado and Wyoming.

COLORADO.

The gas production of Colorado in 1911 was chiefly from a well located in Boulder County, the product of which is supplied to domestic consumers in the town of Boulder.

There is also a large gas production from the oil wells of this field, some of the wells producing more than sufficient gas for operating purposes. One interesting feature is the establishment of two gasoline plants in this field for the purpose of extracting gasoline from the surplus gas. Both of these plants were in operation in 1911.

A small quantity of gas is produced from the oil wells in the Florence oil field of Fremont County and consumed for field purposes.

The number of gas wells in this State at the close of 1911 was 6, as compared with 4 at the beginning of the year.

The statistics of gas production in Colorado are included with those of Arkansas and Wyoming.

IOWA.

In Louisa County, Iowa, there are 6 shallow wells producing a small quantity of gas which is used for illuminating purposes. The value of the gas consumed for this purpose in 1911 is estimated at $70.

MICHIGAN.

The value of the gas produced from wells in Michigan and consumed in 1911 is $1,330. This gas was produced from wells located in the counties of Macomb, Oakland, St. Clair, and Wayne. The gas was chiefly consumed by the owners of the wells for domestic purposes, there being a total of 16 domestic consumers supplied.

The number of wells from which gas was used in 1911 was 22, of which 6 were drilled in 1911.

NORTH DAKOTA.

There was little change in the condition of the natural-gas industry in North Dakota in 1911 as compared with the condition in 1910. The gas production is from wells in Bottineau, Lamoure, and Renville counties. The wells in Lamoure County are artesian wells from which enough gas is obtained foı use for domestic consumption by the owners of the wells.

The total estimated value of the gas consumed in this State in 1911 was $5,738, which was chiefly used for domestic purposes.

SOUTH DAKOTA.

The report shows a decline in the value of the gas consumed in South Dakota in 1911 as compared with 1910. As already stated in previous reports, the gas produced in this State is from artesian wells located in Hughes, Lyman, Stanley, Sully, and Walworth counties. The gas is principally used on the ranches by the owners of the wells. The cities of Pierre and Fort Pierre are supplying gas to domestic consumers.

At the close of 1911 gas was being used from 41 artesian wells.

The total value of the gas consumed in this State in 1911 is estimated at $16,984.

WYOMING.

There was a slight gain in the consumption of gas in Wyoming in 1911 as compared with 1910. The chief supply is from wells in Bighorn County. Domestic consumers in the towns of Basin and Graybull were supplied from this source. Some of the gas wells in this county were closed in during the year. There is also an abundance of gas from some of the oil wells in this county, some of which was consumed for field purposes during the year.

A few domestic consumers were supplied with gas from wells in Converse County in 1911. Some gas from oil wells in Uinta County was consumed for boiler and illuminating purposes in the field.

The statistics of natural gas production in this State are included with those of Arkansas and Colorado.

IMPORTS.

The imports of natural gas for consumption during the last six years have been as follows:

Value of natural gas imported for consumption, 1906–1911.

1906	$36,906	1909	$6,060
1907	32,107	1910	([a])
1908	22,003	1911	([a])

No exports of natural gas during 1907, 1908, 1909, 1910, and 1911 were reported.

NATURAL GAS IN FOREIGN COUNTRIES.

CANADA.

The petroleum development in Canada has declined rather steadily during the last few years, but there has been much encouraging development in the natural-gas industry. Gas is now piped to Windsor, Sarnia, Chatham, and neighboring towns from wells in the eastern part of Essex and the southern part of Kent counties, Ontario. Gas is also available in the eastern part of Elgin, Norfolk, Haldimand, and Welland counties. The towns and villages of the last three counties are generally supplied with natural gas, and it is piped outside of these limits and used in Brantford, Paris, Galt, Dundas, and Toronto, besides the local use by farmers along the pipe lines.

According to Harry P. Dill, American consul, a deal has been completed combining the natural-gas companies of the western portion of Ontario. The combination represents Buffalo and Canadian interests with a capital of $3,000,000. The companies in the merger are the United Fuel Supply Co., the Volcanic Oil & Gas Co., and the Medina Gas Co.

The new organization will control franchises to supply twenty or more cities and towns and will also contract to supply numerous industries with power.

Among the cities and towns to be covered by this company are Windsor, Chatham, Sarnia, Wallaceburg, Blenheim, Ridgetown, Essex, Petrolia, Dresden, Brighton, and Tupperville.

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[a] No imports reported for 1910 and 1911.

The town of Moncton, New Brunswick, will soon be supplied with natural gas piped from the wells on Petitcodiac River, about 11 miles south of Moncton. The Maritime Oilfields Co. (Ltd.) has 13 productive gas and oil wells, yielding a total measured flow of 37,500,000 cubic feet of gas per day. The stony Creek gas pool has been developed by the company along an anticline of over 1½ miles with a breadth of over half a mile. The wells proved increasingly valuable to the west, and there is room for over 100 additional wells. The Albert County anticlines have been traced a long distance to the west, where natural gas springs occur. Each group of the productive gas sands at Stony Creek contained up to six distinct gas sands, varying from 100 to 200 feet in thickness, with an aggregate thickness of 250 feet. There are abundant markets for this natural gas in the old settled country. It is proposed to extend the market from St. John on the west to Sackville on the east, where perhaps $2,000,000 worth of gas can be disposed of.

In Alberta natural gas is being used in the following towns: Suffield, Bassano, Medicine Hat, Bow Island, Wetaskiwin, and Calgary. The Canadian Western Natural Gas Light, Heat & Power Co. has absorbed the Prairie Fuel Gas Co. and the Calgary Natural Gas Co. It is the intention of the company to lay a main from the large wells at Bow Island across the Lethbridge, thence to McLeod, and northward to Calgary, taking in all intermediate points and supplying gas to all these places at a cost of about one-quarter of the present cost for coal. A supply of 200,000,000 cubic feet per day is expected at Bow Island.

During the boring at what is known as No. 4 well at Bow Island a well 29,000,000 feet in volume was struck, as measured by Eugene Coste.

The following table gives the value of natural gas produced in Canada each year since 1892:

Value of natural gas produced in Canada, 1892–1911.

Year.	Value.	Year.	Value.	Year.	Value.
1892	$150,000	1899	$387,271	1906	$583,523
1893	376,233	1900	417,094	1907	815,032
1894	313,754	1901	339,476	1908	1,012,660
1895	423,032	1902	195,992	1909	1,207,029
1896	276,301	1903	202,210	1910	1,491,239
1897	325,873	1904	328,376	1911	[a] 2,283,427
1898	322,123	1905	379,561		

[a] Includes $96,665, the value of gas produced in Alberta.

A large increase is shown in the production of natural gas in 1911, the total value being reported as $2,283,427, of which $96,665 was the value of gas produced in Alberta and $2,186,762 the value of the gas produced in Ontario. These values represent as closely as can be ascertained the value received by the owners of the wells for gas produced and sold or used and do not necessarily represent what the consumers have to pay for the gas, since in many cases the gas is resold once or twice by pipe-line companies before reaching the consumer.

The total quantity of gas consumed in Ontario was about 12,311,974,000 cubic feet and in Alberta probably more than 611,000,000 cubic feet.

Statistics of natural-gas production in the Province of Ontario, Canada, 1902–1911.

Year.	Producing wells.	Miles of gas pipe.	Workmen employed.	Gas production.		Wages for labor.
				Quantity (cubic feet).	Value.	
1902	169	369	107	....	$195,992	$55,618
1903	210	312	138	....	196,535	79,945
1904	176	231	....	....	253,524	53,674
1905	273	462½	130	....	316,476	88,865
1906	332	550	108	2,534,200,000	533,446	64,968
1907	582	810	191	4,155,900,000	746,499	110,832
1908	656	850	152	4,483,000,000	988,616	106,786
1909	744	987	171	5,388,000,000	1,188,179	103,672
1910	828	982	186	7,263,427,000	1,491,239	118,785
1911	1,179	1,296	287	12,311,974,000	2,186,762	183,663

MEXICO.

Natural gas, more or less associated with the oil fields, is being developed with considerable energy in Mexico. The Huastaca Co. is making efforts to utilize natural gas and has succeeded in controlling the gas escaping from several of its wells.

UNITED KINGDOM.

The annual report of the British home office gives the statistics of the production and value of natural gas in the United Kingdom for the year 1902 to 1911, as follows:

Production and value of natural gas at Heathfield,[a] England, 1902–1911.

Year.	Quantity.	Value.
	Cubic feet.	
1902	150,000	$146
1903	972,460	944
1904	774,800	754
1905	(b)	(c)
1906	(b)	(c)
1907	(b)	(c)
1908	(b)	(c)
1909	236,800	(c)
1910	262,000	(c)
1911	(d)	....

[a] Heathfield in Sussex County.

[b] None reported. The railway station at Heathfield, however, is lighted with it, but the quantity is not ascertained.

[c] Not stated.

[d] Not available.

ITALY.

The Rivista Minerario gives the production and value of natural gas in Italy from 1903 to 1911, as follows:

Production and value of natural gas in Italy, 1903–1911.

Year.	Quantity (cubic meters).	Value.
1903	2,255,596	$15,024
1904	2,551,396	16,715
1905	3,092,000	19,310
1906	5,723,469	32,394
1907	5,710,000	32,279
1908	6,737,500	33,809
1909	8,268,000	42,287
1910	8,840,000	73,301
1911	(a)	(a)

[a] Not available.

HUNGARY.

The natural gas pools discovered in Transylvania a few years ago, as described in the last report of this series, received great attention from the Government under the minister of finance, and during the year the actual utilization of the gas began in the immediate neighborhood of the wells for industrial as well as domestic purposes. The Government estimated the general gas-yielding region as comprising some 5,800 square miles, and thus far 20 test wells have been sunk, varying in depth from 1,000 to 3,300 feet. The results have been sufficient to assure a fairly permanent supply. It is probable that the gas will eventually be brought to Budapest. The wells are in the immediate vicinity of Kissarmas, about 33 miles from Klausenburg. The gas is very nearly pure methane.

The petroleum discovered in the Iza Valley will probably also yield sufficient casing-head gas for the manufacture of gasoline.

GALICIA.

Until about two years ago the natural gas emitted from the borings for petroleum in the Boryslaw-Tustanowice oil fields was generally allowed to escape. Recently, in addition to the use of the gas for heating and power in the oil fields, a pipe line conveys the superfluous gas to the oil refinery at Drohobycz, about 5 miles away. This natural gas is colorless. It has only a faint odor of crude petroleum. It contains about 85.5 per cent of methane (marsh gas) and about 8.75 per cent of other hydrocarbons, with from 3 to 6 per cent of nitrogen. Carbon dioxide is not mentioned in the analyses. Its specific gravity is about 0.75 as compared with air, and the heating capacity 10,835 calories per cubic meter. About 3,000,000 cubic feet of gas are consumed per day in the refinery, and the pipe line is about double that capacity. The different gathering lines unite at Kamilla in Tustanowice, where a central power station will eventually be established. Here the gas is freed from moisture before entering the main pipe. A small amount of mercaptan is introduced into the gas at this point in order to detect leaks by its strong odor.

RUSSIA.

The total quantity of gas produced in Russia in 1911 amounted to about 2,000,000,000 cubic feet of gas. It was produced by the Baku Petroleum Co., the Benkendorff Co., Mirzoeff Bros., and Nobel Bros.

This represents the gas utilized. A very much larger quantity is still allowed to go to waste.

GASOLINE FROM NATURAL GAS.

During the last three years the separation of the more volatile grades of gasoline from natural gas issuing from oil wells has become a profitable industry of increasing importance. The various methods used in compressing and cooling natural gas to extract this gasoline have been described fully in the technical press and in Technical Paper No. 10 of the Bureau of Mines, entitled "Liquefied products from natural gas, their properties and uses." From this it is evident that natural gas from various regions will yield from no gasoline to as much as 8 or 10 gallons per thousand cubic feet, the average being perhaps 2 gallons per thousand cubic feet. These methods of extraction have gone in certain cases to the extreme of making air-tight connections of gas pumps to the casing of oil wells, and, in effect, distilling gasoline of ordinary quality from the oil in the sands below by producing a strong vacuum with these pumps. It is quite probable that the industry here suggested may receive considerable extensions as the process is gradually improved.

Inasmuch as the gasoline extracted from natural gas is statistically distinct from the gasoline product of the refineries and comes from the wells as a natural product, which has not been accounted for statistically in either the oil product or the gas product, it has been considered desirable to undertake to collect statistics of production of this material, and the tentative results, manifestly imperfect, are tabulated below.

The industry did not progress as rapidly in 1911 as was expected. Undoubtedly it will eventually become a settled and flourishing business as there are millions of cubic feet of gas now wasted on leases which might be converted into gasoline, should the demand and price warrant it. In view of the newness of the industry the statistics concerning the production of gasoline from natural gas during the year 1911 are very gratifying. In many instances plants were operated intermittently and no records were kept of the output, Statements from such producers could only be estimated, and the figures given in this connection must be regarded as only approximately correct. However crude the method of manufacture, a report of the quantity of gasoline produced has been sought and the following table gives the total production of gasoline from natural gas as reported for 1911:

Production of gasoline from natural gas in the United States in 1911, by States.

State.	Number of operators.	Plants.		Gasoline produced.			Gas used.		Average yield in gasoline.
		Number.	Daily capacity.	Quantity.	Value.	Value per gallon.	Estimated quantity.	Value.	
			Gallons.	*Gallons.*		*Cents.*	*Cubic feet.*		*Gallons.*
West Virginia	46	71	16,694	3,615,251	$258,619	7.15	1,237,928,600	$74,876	2.92
Ohio	27	40	6,579	1,723,899	122.203	7.09	484,644,000	38,772	3.56
Pennsylvania	43	50	5,669	1,467,043	109,649	7.47	526,152,663	52,615	2.79
Oklahoma	8	8	4,800	388,058	20,975	5.40	144,629,000	4,378	2.68
California Colorado Illinois New York	7	7	3,358	231,588	20,258	8.75	82,343,000	6,320	2.81
Total	131	176	37,100	7,425,839	531,704	7.16	2,475,697,263	176,961	3.00

There are two recognized methods of taking gasoline from gas. Some gases will not yield gasoline without being compressed under high pressure; other gases will make gasoline simply by cooling without any compression whatever. In addition to the fully equipped compressor plant, there is the simple and inexpensive method called the gas pump or vacuum process. It is said that some of these pumps have been producing gasoline in the vicinity of Tidioute, Pa., for 40 years, but the gasoline was not sold or even saved until about 12 years ago (1899). Since 1910 the producers at that place have manufactured it successfully. In using a gas compressor for extracting gasoline from natural gas, the gas is compressed to a pressure of from 100 to 300 pounds per square inch before it will condense, depending upon the degree of saturation of the gas with gasoline. By the vacuum process the gas goes through the pump and is discharged against a pressure of 5 ounces. No particular machinery is required to obtain the gasoline, it being necessary to run these pumps in connection with the oil-producing part of the business.

After the gasoline is extracted from the gas, the latter is usually delivered back to the original producer and is used to pump the oil wells from which it first came. When gas is purchased from oil producers it is usually paid for at a certain amount per well per annum and the exhaust gas is returned to the plant for fuel. Some operators take away from leases only the gasoline produced, paying so much per gallon for the gasoline, the gas being retained on the leases. In some places the gas is sold for distribution to consumers for domestic use.

Royalty on natural gasoline.—A point of great interest to the natural-gas operators has arisen in connection with the forms of leases in cases where part of the gas is used for extracting gasoline. Leases drawn at this time provide for a royalty on the gasoline if the gas is used for its extraction, but in the old leases the working interest is generally required to pay for gas only. Some companies secure gasoline from casing-head gas obtained by pumping old oil wells with a strong vacuum. The gas goes to operating the oil pumps. The land owners receive one-eighth of the net proceeds from the gasoline after operating expenses of the plant are deducted. Further comment on the general practice in this matter will be made in the report for 1912.

PENNSYLVANIA AND NEW YORK.

New York, so far as reported, had only one producer of gasoline from natural gas in 1911. This was the Bolivar Gasoline Co., using gas from wells in Allegany County. Those tested usually 3 gallons of gasoline per 1,000 cubic feet of gas.

Pennsylvania was first to introduce the saving of gasoline from natural gas. Fifty plants operated by 43 companies produced gasoline in the State in 1911 to the amount of 1,467,043 gallons, valued at $109,649, or 7.47 cents per gallon. The gas treated to extract the gasoline aggregated 526,152,663 cubic feet, and was valued at $52,615. The average yield was 2.79 gallons per 1,000 cubic feet of gas.

Yield of natural gas in gasoline in Pennsylvania in 1911.

County.			Yield of gas in gasoline per M. cubic feet.	Average gravity of gasoline as produced and before blending.
Location of plant.	Number of operators.	Number of plants.		
			Gallons.	*°Baumé.*
Allegheny	2	4	2.4–6	86– 87
Armstrong	1	1		
Washington	1	2		
Butler	16	19	1 –6	75– 93
Forest	1	1	2 –6	75– 90
McKean	2	2		
Venango	1	1		
Warren	19	20	1 –3	76–100
Total	43	50		

WEST VIRGINIA.

West Virginia ranked first in 1911 as a producer of natural gasoline, contributing 3,615,251 gallons, nearly one-half of the product of the entire country. There were 79 establishments operating in the State, owned by 46 companies. They treated in all 1,237,928,600 cubic feet of gas, valued at $74,876; the gasoline brought $258,619. The yield averaged 2.92 gallons per 1,000 feet of gas.

Yield of natural gas in gasoline in West Virginia in 1911.

County.			Yield of gas in gasoline per M. cubic feet.	Average gravity of gasoline as produced and before blending.
Location of plant.	Number of operators.	Number of plants.		
			Gallons.	*°Baumé.*
Brooke	4	5	1.5–8	87–94
Calhoun	1	1	1–5	83.2–92
Hancock	1	1		
Harrison	1	2		
Marion	1	1		
Marshall	1	1		
Pleasants	10	13	2–2.5	75–91
Ritchie	5	7	1.5–4.6	83.2–96
Tyler	16	34	1.5–9	79–95
Wetzel	2	2	1.5–3	80–89
Wirt	1	1		
Wood	3	3	1–4.5	87–89
Total	46	71		

OHIO.

Ohio was second in the production of gasoline, furnishing 1,723,899 gallons, valued at $122,203, or 7.09 cents a gallon. Less gas was used than in the other States, for the yield per 1,000 cubic feet was 3.56 gallons. The gasoline averaged 7.09 cents a gallon in price.

Yield of natural gas in gasoline in Ohio in 1911.

County.			Yield of gas in gasoline per M. cubic feet.	Average gravity of gasoline as produced and before blending.
Location of plant.	Number of operators.	Number of plants.		
			Gallons.	*°Baumé.*
Athens	1	1	2–5	[a] 88–92
Fairfield	1	1		
Jefferson	1	1		
Wood	1	1		
Columbiana	2	2	2–5	80–91
Morgan	2	3		
Monroe	7	17	0.5–9	70–95
Washington	12	14	1–9	80–95
Total	27	40		

[a] Not complete.

OKLAHOMA.

The following is a list of some of the companies producing gasoline from natural gas in Oklahoma: Blair Oil & Refining Co., J. G. Bradstreet & Co., and the Gasoline Refining Co., in Muskogee County;

Franchot & Co., Oklahoma Natural Gasoline Co., and the Standard Oil Co. of Oklahoma, in Creek County; Alluwe Oil Co. and Producers Pipe Line Co., in Nowata County; and White Turkey Oil Co., in Washington County. C. A. Wall Gas Manufacturing Co. is installing a plant in Okmulgee County. Hogan, Coe & Co. have done some experimental work in Creek County.

Reports received from producers of gasoline from natural gas indicate that approximately 388,058 gallons of gasoline were produced, valued at $20,975 in 1911. In the production of this gasoline not less than 144,629,000 cubic feet of gas was compressed. The average yield of gasoline per 1,000 cubic feet of gas used was 2.68 gallons. The yield of gasoline per 1,000 cubic feet of gas used varied from one-fourth of a gallon to 4 gallons. The gravity of the gasoline produced varied between 67° and 86° Baumé. The average price received for the gasoline was 5.4 cents a gallon, the price ranging from 3 to 10 cents. The exhaust or residue gas was generally consumed on the leases or delivered for fuel purposes to consumers in the immediate vicinity.

COLORADO.

Two gasoline plants have been installed in the Boulder field, Colo., for the extraction of gasoline from the surplus gas from oil wells. It is estimated that 4 gallons of gasoline can be extracted from 1,000 cubic feet of the gas. Both plants were in operation in 1911.

CALIFORNIA.

Only one gasoline plant, the Pacific Gasoline Co., was in successful operation in California in 1911. This plant is located in the Brea Canyon oil field, Orange County, where the gas is said to yield 2 gallons of gasoline per 1,000 cubic feet of gas. A few companies are installing plants in this State—Western Gasoline Co. and Purity Gasoline Co., at Orcutt, to use gas from wells in Santa Barbara County; Puente Oil Co., at Puente; Menges Oil Co., at Brea Canyon, Orange County; Dome-Pinal Refining Co., at Santa Maria. The Union Oil Co. of California expects to install a plant near Orcutt. The Honolulu Consolidated Oil Co. has a plant in the Kern County oil field, but did not operate except experimentally in 1911.

ILLINOIS.

Reports were received from three companies which were producing gasoline from natural gas in Illinois in 1911, the Kewanee Oil and Gas Co. in Crawford County, the Mahutska Oil Co. in Crawford County, and the Shaffer-Smather Oil Co. in Lawrence County. Two other companies have plants but have not yet been in operation. The average yield of gasoline per 1,000 cubic feet of gas used ranged from 1½ to 3 gallons.

ANALYSES OF NATURAL AND MANUFACTURED GASES.

In comparison with the composition shown in the analytical tables for natural gas, the following table gives for comparison the general composition of coal gas, water gas, and producer gas from bituminous coals. The weights in pounds, the specific gravity, and the usual number of heat units per thousand cubic feet of the various gases are given according to the usually accepted values.

Analyses, weight, and heating quality, per 1,000 feet, and specific gravity, of natural and manufactured gases.

Constituent.	Average of coal gas.	Average of water gas.	Average of producer gas from bituminous coal.
	Per cent.	*Per cent.*	*Per cent.*
Marsh gas (CH_4)	40.00	2.00	2.05
Other hydrocarbons	4.00	.00	.04
Nitrogen	2.05	2.00	56.26
Carbonic acid (CO_2)	.45	4.00	2.60
Carbonic oxide (CO)	6.00	45.50	27.00
Hydrogen	46.00	45.00	12.00
Hydrogen sulphide	.00	.00	.00
Oxygen	1.50	1.50	.05
Total	100.00	100.00	100.00

Average gases.	Pounds in 1,000 cubic feet.[a]	Specific gravity, air being 1.	British thermal units per 1,000 cubic feet.[b]
Natural gas:			
Pennsylvania and West Virginia	47.50	0.624	1,145,000
Ohio and Indiana	48.50	.637	1,095,000
Kansas	49.00	.645	1,100,000
Coal gas	33.00	.435	755,000
Water gas	45.60	.600	350,000
Producer gas from bituminous coal	75.00	.985	155,000

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[a] 1,000 cubic feet of air at an atmospheric pressure of 14.7 pounds and at a temperature of 62° F. weighs 76.1 pounds and is a mechanical mixture of 23 parts of oxygen and 77 parts of nitrogen by weight.

[b] A British thermal unit is the heat necessary to raise the temperature of 1 pound of pure water at 39° F. 1°.

THE COMPOSITION OF NATURAL GAS.

In order to comply with many demands made for the information, a compilation has been made of enough of the analyses of natural gas which have thus far been published to give a general idea of the composition of natural gas in the principal producing fields in this country and indications of the quality of this material in foreign localities.

These analyses are not presented as covering the subject in at all a satisfactory manner, as many analyses were made many years ago when the methods of analysis and even the methods of sampling were comparatively faulty. It has been shown by a number of authorities, including Francis C. Phillips, of Allegheny, Pa., and G. A. Burrell, of the United States Bureau of Mines, that many of the supposed constituents of natural gas do not in fact exist there, for example, free hydrogen and carbon monoxide. Nevertheless these items have been presented in these analyses in order to show the analysis just as it was made. Such exceptional components have been included with other components under the heading "Other constituents." The four columns giving methane, carbon dioxide, nitrogen, and oxygen are those of real value for comparing the composition of natural gas in different regions. The oxygen column is only valuable as showing extended mixtures of air usually in the course of sampling. Another constituent which is really of value is hydrogen sulphide, which, on account of being found occasionally only, is included in the column of other constituents.

Occasion is taken here to announce the publication in the near future of a paper on methods and results of the analysis of natural gas, by G. A. Burrell, of the United States Bureau of Mines, which will appear as a contribution to the proceedings of the Eighth International Congress of Applied Chemistry.

The composition of natural gas in the principal producing regions.

State and district.	Collected from—	Constituents.						Remarks.	Analyst.	Where published.
		Methane (marsh gas).	Other hydrocarbons.	Carbon dioxide.	Nitrogen.	Oxygen.	Other constituents.			
Alabama:										
Fayette County—										
Fayette	Well	98.30		0.30	1.30	0.10		Collected by D. T. Day, July, 1910.	G. A. Burrell	
California:										
Contra Costa County	Wells on Miner ranch California Gas & Electric Co.	93.00		.40	3.30		H 3.30	Specific gravity, 0.558, collected 1904.	A. Auchie Cunningham.	Bull. U. S. Geol. Survey No. 340, 1908, p. 342.
Do	do	92.30					H 7.50	Loss in sampling, etc., 2 per cent, collected 1907.	do	Do.
Fresno County—										
Coalinga field	Several wells, Kern Trading & Oil Co.	88.00		11.10	.90			Collected by G. H. Salisbury, June 10. 1910.	G. A. Burrell	Bull. U. S. Bur. Mines No. 19, p. 56.
Kern County—										
Kern River field	Reed 1 A well, Associated Oil Co.	84.30	8.00	6.50	1.20			Collected by C. Ballah, Nov. 24, 1909.	do	Do.
King County—										
Sunset field	Well No. 1, Crandall	87.70		10.50	1.80			Collected by Irving C. Allen, July 14, 1909.	do	Do.
McKittrick field	Several wells, Dabney	66.20	1.00	30.40	2.40			Collected by Irving C. Allen, Sept. 6, 1909.	do	Do.
Los Angeles County—										
West Los Angeles	Well No. 1—Pacific Petroleum Co.	91.00	2.70	1.00	5.20	.10		Collected by Irving C. Allen, July 23, 1909.	do	Do.
Los Angeles	Gas-producing oil well.	83.70	.20	6.68	6.31	2.86	CO .25	Collected by Chas. R. Fletcher.	Hamilton P. Cady and David F. McFarland.	Jour. Am. Chem. Soc., vol. 29, p. 1530.
Napa County—										
Mount Helena	Cracks in rocks, Phoenix mine.	61.49		.74	31.44	6.33		Depth 150 to 300 feet	Dr. Melville	Mon. U. S. Geol. Survey vol. 13, 1888, p. 373.
Orange County—										
Fullerton field	Several wells, C. V. Hall.	86.70	9.50	1.70	2.10			Collected by Irving C. Allen, July 22, 1909.	G. A. Burrell	Bull. U. S. Bur. Mines No. 19, p. 56.
Do	Well No. 52, Petroleum Development Co.	85.80	10.90	1.40	1.90			Collected by J. Collins, Nov. 17, 1909.	do	Do.

San Joaquin County—										
Stockton	Well No. 2	60.47	....	Tr.	26.66	1.00	CO H	trace 11.87	Specific gravity, 0.612	Price & Son, San Francisco.	Bull. State Min. Bur. California, No. 3, p. 75.
Do	Well No. 5	62.93	....	.50	24.36	.70	CO H	trace 11.51	Specific gravity, 0.607	do	Do.
Do	Stockton Natural Gas Co.	83.00	....	.05	....	.06	CO H	trace .06	Air introduced in sampling, etc., 16.83 per cent.		Mineral Resources U. S for 1888; U. S. Geol. Survey, 1890, p. 510.
Santa Barbara County—											
Santa Maria field	Several wells	62.70	20.20	15.50	1.40	.20			Collected by Irving C. Allen, Aug. 5, 1909.	G. A. Burrell	Bull. U. S. Bur. Mines No. 19, p. 56.
Do	Well No. 5—Santa Maria Oil & Gas Co.	64.60	19.00	14.10	2.10	.20			Collected by W. W. Bradbury, Nov. 11, 1909.	do	Do.
Ventura County—											
Torrey field	Several wells, Torrey	54.20	35.60	6.80	3.40	....			Collected by B. B. Grinnell, Feb. 18, 1910.	do	Do.
Illinois:											
Pike County—											
Pittsfield	Well	73.81	....	.81	21.92	3.46					Bull. Geol. Survey Illinois, No. 2, p. 82.
Indiana:											
Delaware County—											
Muncie	Wells Nos. 1, 2, 3, 4, and 6.	92.67	.25	.25	3.53	.35	H H_2S CO	2.35 .15 .45		Prof. H. C. Howard.	Eighth Ann. Rept. U. S. Geol. Survey, 1889, p. 592.
Grant County—											
Marion	Well No. 3	93.58	.15	.90	3.42	.55	H HS CO	1.20 .20 .60		do	Do.
Do	Well	77 40	15.04	.73	6.66	....	He	.17	Collected by B. A. Kinney, Aug. 25, 1906.	Hamilton P. Cady and David F. McFarland.	Jour. Am. Chem. Soc., vol. 29, p. 1530.
Howard County—											
Kokomo	Wells Nos. 1 and 2	94.16	.30	.29	2.80	.30	H HS CO	.18 .18 .55		Prof. H. C. Howard.	Eighth Ann. Rept. U. S. Geol. Survey, 1889, p. 592.
Madison County—											
Anderson	McCullough well	93.07	.49	.26	3.02	.42	H HS CO	1.86 .15 .73		do	Do.
Kansas:											
Allen County—											
Iola	Well	89.66	....	.90	7.76	.45	CO	1.23		E. H. S. Bailey	Mineral Resources U. S. for 1896; U. S. Geol. Survey, 1897.
Moran	do	92.00	.35	.30	6.35	.20	He H CO	.21 .39 .20	Collected July 13, 1906	Hamilton P. Cady and David F. McFarland.	Jour. Am. Chem. Soc., vol. 29, p. 1530.

The composition of natural gas in the principal producing regions—Continued.

State and district.	Collected from—	Constituents.						Remarks.	Analyst.	Where published.
		Methane (marsh gas).	Other hydrocarbons.	Carbon dioxide.	Nitrogen.	Oxygen.	Other constituents.			
Kansas—Continued.										
Allen County—Contd.										
Iola	Main at office of Iola Gas Co.	94.50			5.08	0.23	H trace He .18	Collected June 10, 1906.	Hamilton P. Cady and David F. McFarland.	Jour. Am. Chem. Soc., vol. 29, p. 1529.
Do	Several wells; main at Iola city gas office.	91.50		0.70	6.97	.40	CO .30 He .13	Collected July 13, 1906.	do	Jour. Am. Chem. Soc., vol. 29, p. 1530.
Humboldt	City main	94.00	2.78		2.98	.10	He .14	do		
Allen and Neosho counties.	Several wells—Mains of Kansas Natural Gas Co. at Lawrence.	94.30	.75	1.94	2.60	.24	He .17	Collected Dec. 12, 1906.	Hamilton P. Cady and David F. McFarland.	Do.
Anderson County— Garnett	City mains	94.30	.52	.20	4.61		He .37	Depth 610 feet; pressure, 200 pounds; collected Aug. 1, 1906.	do	Do.
Butler County— Augusta	City supply	79.10	8.21		12.44		He .25	Depth, 1,440 feet; pressure, 650 pounds; collected Aug. 4, 1906.	do	Do.
Chase County— Elmdale	Wells	78.60	8.26	.15	12.13	.30	He .56	Depth, 152 feet; pressure, 45 pounds; collected Oct. 6, 1906.	do	Do.
Chautauqua County— Peru	Well	81.70	8.11	.51	9.39	.10	He .19	Collected July 20, 1906.	do	Do.
Coffey County— Burlington	City supply—high-pressure supply pipe wells south of Burlington.	85.50	3.40		10.60		He .50	Collected Aug. 4, 1906.	do	Do.
Cowley County— Dexter	Well	14.85	.41		82.70	.20	H Tr. He 1.84	Depth, 310 feet; pressure, 100 pounds; collected 1905.	do	Jour. Am. Chem. Soc., vol. 29, p. 1529.
Do	Greenwell well	14.33	1.06		82.87	.10	H Tr. He 1.64	Collected June 12, 1906.	do	Do.

Cowley County— Arkansas City	City supply	81.10	12.05	.10	6.39	.20	He	.16	Depth, 750 feet; pressure, 355 pounds.	do	Jour. Am. Chem. Soc., vol. 29, p. 1530.
Douglas County— Eudora	Town mains	88.60		.62	10.20	.31	He	.27	Depth, 350 feet; pressure, 200 pounds.	do	Jour. Am. Chem. Soc., vol. 29, p. 1529.
Lawrence	Old well	81.40		.92	17.22	Tr.	He	.46	Depth, 1,200 feet; collected July 4, 1906.	do	Do.
Elk County— Moline	Wells west and south of town.	74.10		.54	24.85		H He	Tr. .51	Depth, 1,150 feet; pressure, 380 pounds; collected, June 24, 1906.	do	Do.
Greenwood County— Eureka	Town supply	51.40		.20	46.40	.50	He	1.50	Collected, Oct. 5, 1906	do	Jour. Am. Chem. Soc., vol. 29, p. 1530.
Do	New field	51.80		.20	46.40	.10	He	1.50	do	do	Do.
Johnson County— Spring Hill	City supply of Olathe.	84.40	.10		15.10	Tr.	He	.40	Depth, 530 feet; pressure, 184 pounds; collected Aug. 2, 1906.	do	Do.
Miami County— Paola	Well	95.20	.11	.33	2.34	.45	CO	1.57		E. H. S. Bailey	Kansas Univ. Quart., 1895, vol. 4, no. 1, p. 10.
Osawatomie	do	97.63	.22	.22	.60		CO	1.33		do	Do.
Do	City supply	98.00		.70	.88	.40	He	.01	Collected, Aug. 3, 1906	Hamilton P. Cady and David F. McFarland.	Jour. Am. Chem. Soc., vol. 29, p. 1530.
Montgomery County— Coffeyville	Well	96.41	.35		2.21	.12	CO	.91		E. H. S. Bailey	Kansas Univ. Quart., 1895, vol. 4, no. 1, p. 10.
Cherryvale		92.46		.22	5.94	.22	CO	1.16		do	Do.
Independence		95.28	.67	.44	3.28	Tr.	CO	.33		do	Do.
Caney	Well east of Caney—Caney Gas & Mining Co.	92.40	.10	.81	6.46	.15	He	.08	Depth, 1,550 feet; pressure, 620 pounds; collected, July 14, 1906.	Hamilton P. Cady and David F. McFarland.	Jour. Am. Chem. Soc., vol. 29, p. 1530.
Liberty and Coffeyville.	Supply of Joplin district—Kansas Natural Gas Co.	95.70	.61	.92	2.69		He	.08	Depth, 950 feet; pressure, 450 pounds.	do	Do.
Neosho County— Chanute	City supply—wells east of city.	94.70			4.96	.10	He	.24	Depth, 850 feet; pressure, 200 pounds; collected, July 24, 1906.	do	Do.
Do	Pipe line of Kansas Natural Gas Co. at Lawrence:										
	Sample 1	98.00			1.88	.12			Collected, Oct. 23, 1905	do	Jour. Am. Chem. Soc., vol. 29, p. 1529.
	Sample 2	98.06		.20	1.57	Tr.	He	.17	Collected, May 16, 1906	do	Do.
Erie	City supply—wells east of town.	90.30	4.56	.33	4.45	.22	He	.13	Depth, 510 feet; pressure, 150 pounds; collected, July 3, 1906.	do	Do.

The composition of natural gas in the principal producing regions—Continued.

State and district.	Collected from—	Constituents.						Remarks.	Analyst.	Where published.
		Methane (Marsh gas).	Other hydrocarbons.	Carbon dioxide.	Nitrogen.	Oxygen.	Other constituents.			
Kansas—Continued.										
Wilson County—										
Eson district	Pipe line supplying Parsons—Prairie Oil & Gas Co.	91.90	3.37	0.72	3.74	Tr.	He 0.27		Hamilton P. Cady and David F. McFarland.	Jour. Am. Chem. Soc., vol. 29, p. 1529.
Neodesha	Well	90.56	.22	1.00	7.07	0.65	CO .50		E. H. S. Bailey	Kansas Univ. Quart., 1895, vol. 4, no. 1, p. 10.
Fredonia	Town supply	82.25	.12	.61	16.40		He .62	Depth, 1,085 feet; pressure, 300-480 pounds.	Hamilton P. Cady and David F. McFarland.	Jour. Am. Chem. Soc., vol. 29, p. 1529.
New Albany	Well	89.10	.25	.20	9.84		H .12 He .49	Collected, July 25, 1906.	do	Jour. Am. Chem. Soc., vol. 29, p. 1530.
Buffalo	Well inside town	96.20	.78		2.46		H .18 CO .11 He .27	Collected July 8, 1906.	do	Do.
Altoona		92.00	2.85	.92	3.97		He .26	Collected. July 25, 1906.	do	Do.
Wyandotte County—										
Bonner Springs	Well of Bonner Portland Cement Co.	97.18			2.36	.10	H .25 He .10	Depth, 600 feet; pressure, 190 pounds; collected July 8, 1906.	Hamilton P. Cady and David F. McFarland.	Jour. Am. Chem. Soc., vol. 29, p. 1529.
Louisiana:										
Caddo field	Well	95.00		2.34	2.56		.01		F. C. Phillips	Bull. U. S. Geol. Survey No. 429, 1910, p. 138.
Calcasieu Parish—										
Jennings	Gas-producing oil well.	88.40	1.83	1.80	5.76	1.81	CO .40 He trace.	Small amount of air in sample; collected July, 1907, by A. Reineke.	Hamilton P. Cady and David F. McFarland.	Jour. Am. Chem. Soc., vol. 29, p. 1530.
Iberville Parish—										
Grosse Tete	S. R. Ely well	58.80		1.40	39.80			35.4 per cent of air extracted before analyzing. Depth, 120 feet; collected July 17, 1910, by D. T. Day.	G. A. Burrell	Unpublished.
Whitecastle		90.70		4.20	5.10			Collected July, 1910, by D. T. Day.	do	Do.
Ouachita Parish—										
Monroe		94.20		1.40	4.40			16.8 per cent of air extracted before analyzing; collected July, 1910, by D. T. Day.	do	Do.

Terrebonne Parish—										
Montegut	Phyllis well—Lower Terrebonne Refining Co.	89.10	4.45	1.00	3.50	.10	H 1.75 H_2S .001 CO .10		Professor Thile	Bull. U. S. Geol. Survey No. 429, 1910.
Washington Parish—Bogalusa		62.20		3.00	34.80	Trace.		Collected 1910 by D. T. Day.	G. A. Burrell	Unpublished.
Missouri:										
Jackson County—Kansas City	Well at 2416 Tracy Avenue.	87.20	8.23	.60	3.65	.10	CO .20 He .01	Depth, 300 feet; pressure very low.	Hamilton P. Cady and David F. McFarland.	Jour. Am. Chem. Soc., vol. 29, p. 1530.
Sheffield	Wells at Sheffield Nut & Bolt Works.	92.90	.50	.83	5.43	.20	CO .10 He .04	Shallow wells; pressure 40 pounds.	do	Do.
Nevada:										
Churchill County—Stillwater	Artesian well	72.36		4.22	22.86	.56		Burns blue and white flame. Depth, 345 feet; collected March, 1911, by C. V. Lindner.	G. A. Burrell	Unpublished.
Do	An old slough 15 inches in diameter.	95.60		1.26	3.14			Burns blue and white flame; collected March, 1911, by C. V. Lindner.	do	Do.
Do	Artesian well	70.91		5.01	23.66	.42		Burns blue and white flame. Depth, 345 feet; collected March, 1911, by C. V. Lindner.	do	Do.
New York:										
Cattaraugus County—Olean		96.50	1.00			2.00	CO .50	Specific gravity, 0.692	Robert Young	Mineral Resources U. S. for 1883-84, U. S. Geol. Survey, 1885, p. 235.
Chautauqua County—Fredonia	Mains at Fredonia Natural Gas Light Co.	90.05		.41	9.54				F. C. Phillips	Second Geol. Survey Pennsylvania, 1886, pt. 1, p. 800.
Onondaga County—Baldwinsville	Well	98.40	.25		.40	Trace.	H trace. CO .95		Dr. Durand Woodman.	Bull. N. Y. Museum No. 30, p. 468.
Ontario County—West Bloomfield	do	82.41	2.94	10.11	4.31	.23		Specific gravity, 0.693	Professor Wurtz	Am. Inst. Min. Eng., vol. 13, p. 542.
North Dakota:										
Bottineau County—Westhope	Wells of North Dakota Gas Co.	82.70	.20		12.40	3.00	H .50 CO 1.20	Pressure 55 to 60 pounds.	E. J. Babcock	Bull. U. S. Geol. Survey No. 431, 1911, p. 7.
Langford		71.15	.10		16.61	7.10	H 4.74 CO .30	Pressure 18 to 20 pounds.	do	Do.

The composition of natural gas in the principal producing regions—Continued.

State and district.	Collected from—	Constituents.						Remarks.	Analyst.	Where published.
		Methane (marsh gas).	Other hydrocarbons.	Carbon dioxide.	Nitrogen.	Oxygen.	Other constituents.			
Ohio:										
Auglaize County—										
St. Marys	Wilkens well	93.85	0.20	0.23	2.98	0.35	H 1.74 H_2S .21 CO .44	Trenton limestone	Prof. C. C. Howard	Mineral Resources U. S. for 1888, U. S. Geol. Survey, 1890, p. 491.
Fairfield County—										
Thurston field	Well	90.48	.30	.25	8.12	.15	H .55 CO .15		do	Bull. Geol. Survey Ohio, No. 4, p. 125.
Hancock County—										
Findlay	Findlay Gas Light Co. wells.	93.35	.35	.25	3.41	.39	H 1.64 H_2S .20 CO .41		do	Mineral Resources U. S. for 1888, U. S. Geol. Survey, 1890, p. 491.
Do		92.61	.30	.26	3.61	.34	H 2.18 H_2S .20 CO .50	Specific gravity 0.570	do	Eighth Ann. Rept. U. S. Geol. Survey, 1889, p. 590.
Knox County—										
Gambier	Neff well	81.40	12.20	.30	4.80	.80	CO .50	Specific gravity 0.640	Professors Newberry and Morley.	Second Geol. Survey Pennsylvania, 1876 L., p. 147.
Noble County—										
Dexter City	Well No. 1, Mitchell farm, Bull Run, near city.	97.00	.70	.11	1.00	.30	CO .80		Chas. F. Mabery and Orton C. Dunn.	Am. Chem. Jour., vol. 18, p. 224.
Do	Well No. 8, Dunn farm, near city.	91.20	2.60	.30	1.20	4.00	CO .40		do	Am. Chem. Jour, vol. 18, p. 223.
Richland County—										
Butler	Well of F. O. Levering.	70.00	17.15		12.38	.05	H .27 He .15	Contains also 0.15 per cent of helium; collected July 19, 1906.	Hamilton P. Cady and David F. McFarland.	Jour. Am. Chem. Soc., vol. 29, p. 1530.
Seneca County—										
Fostoria	Water-tank wells	92.84	.20	.20	3.82	.35	H_2S .15 H 1.89 CO .55		C. C. Howard	Mineral Resources U. S. for 1888, U.S. Geol. Survey, 1890, p. 491.
Oklahoma:										
Kay County—										
Blackwell	Well No. 2—Union Oil & Gas Co.	83.40	10.92		5.19		H .33 He .16	Pressure 185 pounds	Hamilton P. Cady and David F. McFarland.	Jour. Am. Chem. Soc., vol. 29, p. 1530.

Oregon:										
Northwestern	Slough on Brown's dairy farm.	95.50		3.50	1.00			Collected September, 1910, by G. N. Macready and R. F. Rogers.	G. A. Burrell	Unpublished.
Do.	do	95.70		3.30	1.00			Collected by C. W. Washburne.	do	Do.
Do.	Whalen River bed at Luhkarela ranch.	86.20		.70	13.10			Collected by G. A. Macready, September, 1910.	do	Do.
Do.	Herrick Mineral Spring, Grand Rapids, Whalen River.	87.00		.50	12.50			do	do	Do.
Do.	Slough on Brown's dairy farm.	96.10		3.00	.90			Collected by G. A. Macready and R. F. Rogers, September, 1910.	do	Do.
Tillamook	Well 5½ miles southwest of town.	2.00		.15	97.85			Collected by G. A. Macready, September, 1910.	do	Do.
Pennsylvania:										
Allegheny County Creighton	Well	96.34	Tr.	3.64				Specific gravity, 0.592	F. C. Phillips	Mineral Resources U. S. for 1883-84, U. S. Geol. Survey, 1885, p. 235.
Armstrong County—										
Leechburg	Wells	89.65	4.95	.35			CO .26 H 4.79	Average of two analyses; specific gravity, 0.558.	S. P. Sadtler	Second Geol. Survey Pennsylvania, 1876, L., p. 152.
Beaver County— Baden	Bryan No. 1 well—Baden Gas Co.	87.27		.41	12.32	Tr.			F. C. Phillips	Geol. Survey Pennsylvania, pt. 1, 1886, p. 811
Raccoon Creek		90.09		Tr.	9.91	Tr.	Tr.		do	Geol. Survey Pennsylvania, pt. 1, 1886, p. 810.
Butler County—										
Burns	Well No. 1	75.75	17.84	.34			CO Tr. H 6.06	Specific gravity, 0.6148	S. P. Sadtler	Second Geol. Survey Pennsylvania, 1876, L., p. 149.
	Well No. 2	75.12	18.39	.35			H 6.15 CO Tr.			
McKean County—										
Kane	Wilcox well No. 7—United Natural Gas Co.	90.38		.21	9.41	Tr.			F. C. Phillips	Geol. Survey Pennsylvania, 1886, pt. 1, p. 803.
Do.	Well No. 1	90.01		.20	9.79	Tr.			do	Do.

The composition of natural gas in the principal producing regions—Continued.

State and district.	Collected from—	Constituents.						Remarks.	Analyst.	Where published.
		Methane (marsh gas).	Other hydrocarbons.	Carbon dioxide.	Nitrogen.	Oxygen.	Other constituents.			
Pennsylvania—Continued.										
Venango County— Oil City	Main of Northwestern Natural Gas Co.	95.42		0.05	4.51	Tr.	H 0.02	Speechley gas	F. C. Phillips	Geol. Survey Pennsylavania, 1886, pt. 1, p. 805.
Warren County— Sheffield	Wells 1, 2, and 3 of Sheffield Gas Co.	90.64		.30	9.06	Tr.			do	Geol. Survey Pennsylvania, 1886, pt. 1, p. 802.
Washington County— Houston	Well	84.26		.44	15.30	Tr.		Contains also trace of ammonia.	do	Geol. Survey Pennsylvania, 1886, pt. 1, p. 811.
Westmoreland County— Murrysville	Huklill well—Philadelphia Co.	97.70		.28	2.02	Tr.			do	Geol. Survey Pennsylvania, 1886, pt. 1, p. 807.
Grapeville		35.08	29.04	.58	27.87	.16	H 7.05 CO .22		Mr. Morrell	Am. Inst. Min. Eng., vol. 15, p. 531.
Tennessee:										
Shelby County— Memphis	Seepage	90.36		3.13	3.83	.83	H. 1.85	Collected December, 1911, by Dutro, Trimble & Munn.	G. A. Burrell	Unpublished.
Utah:										
Grand County— Moab		90.80		3.60	5.60			Collected by A. H. Rogers, September, 1911.	G. A. Burrell	Unpublished.
Do		90.00		3.50	6.50			Collected by A. H. Rogers.	U. S. Geological Survey Laboratory.	Bull. U. S. Geol. Survey No. 471, 1910.
Salt Lake County— Salt Lake City	12 miles north of city	22.30	38.50	.80	19.70	9.00	H. 16.6 CO 1.2		J. T. Kingsbury	Bull. U. S. Geol. Survey No. 260, 1905, p. 481.
Washington:										
Wahkiakum County— Oneida	John Nelson's ranch(1)	91.20		1.20	7.60			Collected September, 1910, by G. A. Macready.	G. A. Burrell	Unpublished.
	John Nelson's ranch(2)	91.00		1.00	8.00					

West Virginia:										
Marion County, Fairmont.	City supply; Bayard sand.	81.60	14.29	.10	3 21	.20	H. .20 CO .40	....	C. C. Howard....	Geol. Survey W. Va., vol. 1, p. 556.
Monongalia County, Morgantown.	Well No. 1, 10 miles west of town.	88.10	8.02	....	3.60	....	He .09 H. .25 CO .24	Depth, 1,800 feet; pressure, 160 pounds; collected by B. H. Hite, Aug. 18, 1906.	Hamilton I. Cady and David F. McFarland.	Jour. Am. Chem. Soc., vol. 29 p. 1530.
Foreign:										
Austria—										
Wels........	....	97.10	....	1.30	1.00	.60	....	Specific gravity, 0.5667..	....	J. Gasbel, 55, 154-5, J. Frank.
Germany—										
Neuengamme near Hamburg.	....	91 50	2.10	.30	4.60	1.50	....	....	....	J. Gasbel, 54, 193–8, Schertel.
Hungary........	Unutilized wells........	92.05	... .	.65	7.30	....	....	....	....	Oest. Chem. Tech. Ztg., 28, 16.
Russia—										
Samara........	Well at Nov-Usensk...	53.35	.40	1.17	40 86	4.22	....	....	....	Petroleum, 5, 517.

PETROLEUM.

By David T. Day.

INTRODUCTION.

The output of crude petroleum in 1911 exceeded the previous maximum in 1910 by 10,892,143 barrels, or more than 5 per cent. In 1911 the production was 220,449,391 barrels and in 1910 it was 209,557,248 barrels.

The total production of the world also surpassed all records, amounting to 345,512,185 barrels, or 46,526,334 metric tons. Of this the United States produced 63.8 per cent, or almost two-thirds.

This maximal production carried with it many features unusual in their interest to the public. The increase was caused chiefly by the gain in California, unwelcome to everyone and impossible to prevent, even after earnest effort to limit the production. The efforts to extend California's consumption were partly successful, and although the stock there increased to 44,000,000 barrels, it is to be realized that this quantity is little over a half-year's supply. Another factor in the increase was the discovery of a saline dome at Vinton, La., which ran the eccentric course that is one of the characteristics of these domes. The Caddo oil field also grew in importance and was scarcely less eccentric than Vinton.

A find of high-grade oil at Electra, in northern Texas, became important at the end of the year. The extension of the Oklahoma fields well into Osage and Pawnee counties, and the discovery of oil still farther west in Kay County substantially increased the Mid-Continent yield.

All these increases in the Mid-Continent fields were offset by the declines in Illinois and in States farther east. In short, fuel oils increased and refinery oils declined

Another feature whose influence is being felt in 1912 was the increase in transporting and refining capacity and of export demand, which in spite of the increase led to a drain on stocks in the Mid-Continent fields. The inevitable result of this situation has been the general increase in the price of crude oil for refining.

The fact that, with an increase in total production of 10,892,143 barrels, prices increased at the end of the year is a paradox which manifests the statistical necessity for an analysis of this total production in order to show the real elements of use which these various oils can yield. In general, the three commodities of general market value which should be considered in regard to these crude oils are gasoline, kerosene, and residuals suitable for fuel in the West and for lubricants and wax in the East. In the trade, "naphtha" is a name generally applied to groups of oils lighter than kerosene as distilled from the crude, but to the public "gasoline" is the name for the light fraction suitable for internal-combustion engines, and in fact when the crude naphtha is redistilled it is for the most part separated so as to yield gasoline and lighter or heavier kerosene. Here let it be remarked that the demand for gasoline has become so imperative and this product so salable that little or none is now allowed to lower the safety of lamp oils. The latter have, therefore, greatly improved in character. The actual need of State inspection of lamp oils has greatly decreased, until the position of local oil inspector has sunk to that of a political sinecure, the money involved in which might be spent with greater general benefit in enforcing the State laws for the conservation of oil and gas deposits.

ACKNOWLEDGMENTS.

The statistical portion of this report is the result of cooperative work between the Government and the petroleum producers, the transportation companies, especially the pipe-line companies, and the consumers. This cooperative work has been entirely voluntary, without any obligatory legislation whatever being invoked on the part of the Government. The amount of service thus rendered has involved many weeks of work by the statistical officers of large corporations and by all of the 14,000 contributors, and it is here gratefully acknowledged, as is also the skilled work of the petroleum accountants in the Survey.

As heretofore, the result has been obtained under two independent systems of statistics. Under one system returns are made direct to the Survey by the pipe lines as to the quantity of oil collected from the field, this information being supplemented by returns from railroads and refineries as to oil which was collected but did not go through pipe lines. Under the other system the returns are from the producers of petroleum as to the quantity produced by them and marketed in 1911 plus the quantity used in the field.

By this means two totals are obtained, and when these two totals agree closely it is assured that the report is substantially correct. An interesting result, which is hereby demonstrated, is the remarkable accuracy of the pipe-line statistics.

In the important States of Alabama, Illinois, Kansas, Kentucky, Michigan, Missouri, Oklahoma, Pennsylvania, and Texas the statistics from the producers have been collected in cooperation with the State geologists, and appreciation is hereby expressed for the arduous labor carried on by these officers in order to make the reports complete at the earliest possible date. In this work the officials in Pennsylvania and Illinois have been particularly prompt as well as successful. The general information furnished would have been impossible without the complete and expensive system of correspondence maintained by the petroleum press, especially the Oil City Derrick, whose field reports have been accepted as authoritative; the Independence Daily Reporter; the Oil and Gas Journal, of Tulsa, Okla., whose field reports are accepted for Texas and Louisiana; the Oil, Paint, and Drug Reporter; the Petroleum Gazette; the California Derrick; the California Oil World; the Oil Age; the Moniteur du Pétrol Roumain; the Petroleum Review, of London; the Petroleum, of Berlin; and the Petroleum World, of London.

The statistics of foreign countries have been obtained chiefly by direct correspondence with the officials of the Governments concerned, as well as by the aid of many private authorities.

PRODUCTION.

The statement of the production of petroleum in 1910 and 1911 is given in detail by States in the tables which follow:

Total quantity and value of petroleum produced in the United States and the average price per barrel in 1910 and 1911, by States, in barrels.

State.	1910			1911		
	Quantity.	Value.	Average price per barrel.	Quantity.	Value.	Average price per barrel.
California	73,010,560	$35,749,473	$0.490	81,134,391	$38,719,080	$0.477
Colorado	239,794	243,402	1.015	226,926	228,104	1.005
Illinois	33,143,362	19,669,383	.593	31,317,038	19,734,339	.630
Indiana	2,159,725	1,568,475	.726	1,695,289	1,228,835	.740
Kansas	1,128,668	444,763	.394	1,278,819	608,756	.476
Kentucky	468,774	324,684	.693	472,458	328,614	.696
Louisiana	6,841,395	3,574,069	.522	10,720,420	5,668,814	.529
Michigan Missouri	3,615	4,794	1.326	7,995	7,995	1.000
New York	1,053,838	1,414,668	1.342	952,515	1,248,950	1.311
Ohio	9,916,370	10,651,568	1.074	8,817,112	9,479,542	1.075
Oklahoma	52,028,718	19,922,660	.383	56,069,637	26,451,767	.472
Pennsylvania	8,794,662	11,908,914	1.354	8,248,158	10,894,074	1.321
Texas	8,899,266	6,605,755	.742	9,526,474	6,554,552	.688
Utah Wyoming	115,430	93,536	.810	186,695	124,037	.664
West Virginia	11,753,071	15,723,544	1.338	9,795,464	12,767,293	1.303
Total	209,557,248	127,899,688	.610	220,449,391	134,044,752	.608

Total production of petroleum and percentage of increase or decrease, by States, in 1911, as compared with 1910, in barrels.

State.	Production.		Increase.	Decrease.	Percentage.	
	1910	1911			Increase.	Decrease.
California	73,010,560	81,134,391	8,123,831		11.13	
Colorado	239,794	226,926		12,868		5.37
Illinois	33,143,362	31,317,038		1,826,324		5.51
Indiana	2,159,725	1,695,289		464,436		21.50
Kansas	1,128,668	1,278,819	150,151		13.30	
Kentucky	468,774	472,458	3,684		.0078	
Louisiana	6,841,395	10,720,420	3,879,025		56.70	
Michigan Missouri	3,615	7,995	4,380		121.2	
New York	1,053,838	952,515		101,323		9.61
Ohio	9,916,370	8,817,112		1,099,258		10.98
Oklahoma	52,028,718	56,069,637	4,040,919		7.77	
Pennsylvania	8,794,662	8,248,158		546,504		6.21
Texas	8,899,266	9,526,474	627,208		7.05	
Utah Wyoming	115,430	186,695	71,265		61.74	
West Virginia	11,753,071	9,795,464		1,957,607		16.66
Total	209,557,248	220,449,391	10,892,143		5.20	

RANK OF STATES.

QUANTITY.

California not only led in quantity of product but produced almost half as much again as Oklahoma, the State second in rank. The Mid-Continent field omitted, California produced as much oil as the rest of the United States put together; the United States being omitted, California produced more oil than any entire nation; and if Russia and the United States are omitted, California far surpassed the combined production of all the rest of the world, including Mexico, India, Roumania, Galicia, Japan, and South America.

The rank of the States is easily remembered when one recognizes California, Oklahoma, and Illinois as forming a class by themselves, the lowest (Illinois) producing over 30,000,000 barrels and the three furnishing three-fourths of the entire output. The second division includes Louisiana, West Virginia, Texas, Ohio, and Pennsylvania, in which Louisiana furnished a surprise by giving the greatest product on record for that State and passing to the head of the second division, above West Virginia, Texas, and Ohio, while the slight gain from two pools in Texas put that State in advance of Ohio again. In the third division the largest State production is less than a fourth of the lowest in the class above, and combined these States produced less than 2.2 per cent of the total, or almost within its probable error.

The changes which may be expected in 1912 may advance the rank of West Virginia by the development of the Blue Creek pool, Kansas may change places with Indiana, and Wyoming may head the third division.

Rank of petroleum-producing States, with quantity and percentage produced by each, in 1910 and 1911, in barrels.

1910				1911			
State.	Rank.	Quantity.	Percentage.	State.	Rank.	Quantity.	Percentage.
California	1	73,010,560	34.84	California	1	81,134,391	36.80
Oklahoma	2	52,028,718	24.83	Oklahoma	2	56,069,637	25.44
Illinois	3	33,143,362	15.82	Illinois	3	31,317,038	14.21
West Virginia	4	11,753,071	5.61	Louisiana	4	10,720,420	4.86
Ohio	5	9,916,370	4.73	West Virginia	5	9,795,464	4.44
Texas	6	8,899,266	4.25	Texas	6	9,526,474	4.32
Pennsylvania	7	8,794,662	4.20	Ohio	7	8,817,112	4.00
Louisiana	8	6,841,395	3.26	Pennsylvania	8	8,248,158	3.74
Indiana	9	2,159,725	1.03	Indiana	9	1,695,289	.77
Kansas	10	1,128,668	.54	Kansas	10	1,278,819	.58
New York	11	1,053,838	.50	New York	11	952,515	.43
Kentucky	12	468,774	.22	Kentucky	12	472,458	.22
Colorado	13	239,794	.12	Colorado	13	226,926	.10
Wyoming	14	119,045	.05	Wyoming	14	194,690	.09
Utah	15			Missouri	15		
Michigan	16			Utah	16		
Missouri	17			Michigan	17		
Total	......	209,557,248	100.00	Total	......	220,449,391	100.00

VALUE.

In value of the product the States do not show such wide divergence. The rank in value is the same as for quantity for the first class; West Virginia leads the second division with higher priced oils; and Louisiana, although also yielding much high-grade oil, drops from fourth in quantity to eighth in value.

Rank of petroleum-producing States, with value of production and percentage of each, in 1910 and 1911.

1910				1911			
State.	Rank.	Value.	Percentage.	State.	Rank.	Value.	Percentage.
California	1	$35,749,473	27.95	California	1	$38,719,080	28.89
Oklahoma	2	19,922,660	15.58	Oklahoma	2	26,451,767	19.73
Illinois	3	19,669,383	15.38	Illinois	3	19,734,339	14.72
West Virginia	4	15,723,544	12.29	West Virginia	4	12,767,293	9.52
Pennsylvania	5	11,908,914	9.31	Pennsylvania	5	10,894,074	8.13
Ohio	6	10,651,568	8.33	Ohio	6	9,479,542	7.07
Texas	7	6,605,755	5.16	Texas	7	6,554,552	4.89
Louisiana	8	3,574,069	2.80	Louisiana	8	5,668,814	4.23
Indiana	9	1,568,475	1.21	New York	9	1,248,950	.93
New York	10	1,414,668	1.11	Indiana	10	1,228,835	.92
Kansas	11	444,763	.35	Kansas	11	608,756	.45
Kentucky	12	324,684	.25	Kentucky	12	328,614	.25
Colorado	13	243,402	.20	Colorado	13	228,104	.17
Wyoming	14	98,330	.08	Wyoming	14	132,032	.10
Utah	15			Utah	15		
Michigan	16			Missouri	16		
Missouri	17			Michigan	17		
Total	......	127,899,688	100.00	Total	......	134,044,752	100.00

PRODUCTION OF PETROLEUM IN THE UNITED STATES FROM 1859 TO 1911, INCLUSIVE.

In the following table will be found a statement of the production of petroleum from each producing State of the United States from the year 1859 to and including the production of the year 1911:

Production of petroleum in the United States, 1859–1911, by years and by States, in barrels of 42 gallons.

Year.	Pennsylvania and New York.	Ohio.	West Virginia.	California.	Kentucky and Tennessee.	Colorado.	Indiana.	Illinois.
1859	2,000	....	....	....	....	....	....	....
1860	500,000	....	....	....	....	....	....	....
1861	2,113,609	....	....	....	....	....	....	....
1862	3,056,690	....	....	....	....	....	....	....
1863	2,611,309	....	....	....	....	....	....	....
1864	2,116,109	....	....	....	....	....	....	....
1865	2,497,700	....	....	....	....	....	....	....
1866	3,597,700	....	....	....	....	....	....	....
1867	3,347,300	....	....	....	....	....	....	....
1868	3,646,117	....	....	....	....	....	....	....
1869	4,215,000	....	....	....	....	....	....	....
1870	5,260,745	....	....	....	....	....	....	....
1871	5,205,234	....	....	....	....	....	....	....
1872	6,293,194	....	....	....	....	....	....	....
1873	9,893,786	....	....	....	....	....	....	....
1874	10,926,945	....	....	....	....	....	....	....
1875	8,787,514	....	....	....	....	....	....	....
1876	8,968,906	31,763	120,000	12,000	....	....	....	....
1877	13,135,475	29,888	172,000	13,000	....	....	....	....
1878	15,163,462	38,179	180,000	15,227	....	....	....	....
1879	19,685,176	29,112	180,000	19,858	....	....	....	....
1880	26,027,631	38,940	179,000	40,552	....	....	....	....
1881	27,376,509	33,867	151,000	99,862	....	....	....	....
1882	30,053,500	39,761	128,000	128,636	....	....	....	....
1883	23,128,389	47,632	126,000	142,857	4,755	....	....	....
1884	23,772,209	90,081	90,000	262,000	4,148	....	....	....
1885	20,776,041	661,580	91,000	325,000	5,164	....	....	....
1886	25,798,000	1,782,970	102,000	377,145	4,726	....	....	....
1887	22,356,193	5,022,632	145,000	678,572	4,791	76,295	....	....
1888	16,488,668	10,010,868	119,448	690,333	5,096	297,612	....	....
1889	21,487,435	12,471,466	544,113	303,220	5,400	316,476	33,375	1,460
1890	28,458,208	16,124,656	492,578	307,360	6,000	368,842	63,496	900
1891	33,009,236	17,740,301	2,406,218	323,600	9,000	665,482	136,634	675
1892	28,422,377	16,362,921	3,810,086	385,049	6,500	824,000	698,068	521
1893	20,314,513	16,249,769	8,445,412	470,179	3,000	594,390	2,335,293	400
1894	19,019,990	16,792,154	8,577,624	705,969	1,500	515,746	3,688,666	300
1895	19,144,390	19,545,233	8,120,125	1,208,482	1,500	438,232	4,386,132	200
1896	20,584,421	23,941,169	10,019,770	1,252,777	1,680	361,450	4,680,732	250
1897	19,262,066	21,560,515	13,090,045	1,903,411	322	384,934	4,122,356	500
1898	15,948,464	18,738,708	13,615,101	2,257,207	5,568	444,383	3,730,907	360
1899	14,374,512	21,142,108	13,910,630	2,642,095	18,280	390,278	3,848,182	360
1900	14,559,127	22,362,730	16,195,675	4,324,484	62,259	317,385	4,874,392	200
1901	13,831,996	21,648,083	14,177,126	8,786,330	137,259	460,520	5,757,086	250
1902	13,183,610	21,014,231	13,513,345	13,984,268	185,331	396,901	7,480,896	200
1903	12,518,134	20,480,286	12,899,395	24,382,472	554,286	483,925	9,186,411	....
1904	12,239,026	18,876,631	12,644,686	29,649,434	998,284	501,763	11,339,124	....
1905	11,554,777	16,346,660	11,578,110	33,427,473	1,217,337	376,238	10,964 247	181,084
1906	11,500,410	14,787,763	10,120,935	33,098,598	1,213,548	327,582	7,673,477	4,397,050
1907	11,211,606	12,207,448	9,095,296	39,748,375	820,844	331,851	5,128,037	24,281,973
1908	10,584,453	10,858,797	9,523,176	44,854,737	[a]727,767	379,653	3,283,629	33,686,238
1909	10,434,300	10,632,793	10,745,092	55,471,601	[a]639,016	310,861	2,296,086	30,898,339
1910	9,848,500	9,916,370	11,753,071	73,010,560	[a]468,774	239,794	2,159,725	33,143,362
1911	9,200,673	8,817,112	9,795,464	81,134,391	[a]472,458	226,926	1,695,289	31,317,038
Total	727,493,335	406,475,177	226,856,521	456,437,114	7,584,593	10,031,519	99,562,240	157,911,660

[a] No production in Tennessee recorded.

Production of petroleum in the United States, 1859–1911, by years and by States, in barrels of 42 gallons—Continued.

Year.	Kansas.	Texas.	Missouri.	Oklahoma.	Wyoming.	Louisiana.	United States.	Total value.
1859							2,000	$32,000
1860							500,000	4,800,000
1861							2,113,609	1,035,668
1862							3,056,690	3,209,525
1863							2,611,309	8,225,663
1864							2,116,109	20,896,576
1865							2,497,700	16,459,853
1866							3,597,700	13,455,398
1867							3,347,300	8,066,993
1868							3,646,117	13,217,174
1869							4,215,000	23,730,450
1870							5,260,745	20,503,754
1871							5,205,234	22,591,180
1872							6,293,194	21,440,503
1873							9,893,786	18,100,464
1874							10,926,945	12,647,527
1875							8,787,514	7,368,133
1876							9,132,669	22,982,822
1877							13,350,363	31,788,566
1878							15,396,868	18,044,520
1879							19,914,146	17,210,708
1880							26,286,123	24,600,638
1881							27,661,238	23,512,051
1882							30,349,897	23,631,165
1883							23,449,633	25,740,252
1884							24,218,438	20,476,924
1885							21,858,785	19,193,694
1886							28,064,841	20,028,457
1887							28,283,483	18,856,606
1888							27,612,025	17,950,353
1889	500	48	20				35,163,513	26,963,340
1890	1,200	54	278				45,823,572	35,365,105
1891	1,400	54	25	30			54,292,655	30,526,553
1892	5,000	45	10	80			50,514,657	25,906,463
1893	18,000	50	50	10			48,431,066	28,932,326
1894	40,000	60	8	130	2,369		49,344,516	35,522,095
1895	44,430	50	10	37	3,455		52,892,276	57,691,279
1896	113,571	1,450	43	170	2,878		60,960,361	58,518,709
1897	81,098	65,975	19	625	3,650		60,475,516	40,929,611
1898	71,980	546,070	10		5,475		55,364,233	44,193,359
1899	69,700	669,013	132		5,560		57,070,850	64,603,904
1900	74,714	836,039	[a] 1,602	6,472	5,450		63,620,529	75,752,691
1901	179,151	4,393,658	[b] 2,335	10,000	5,400		69,389,194	66,417,335
1902	331,749	18,083,658	[a] 757	37,100	6,253	548,617	88,766,916	71,178,910
1903	932,214	17,955,572	[a] 3,000	138,911	8,960	917,771	100,461,337	94,694,050
1904	4,250,779	22,241,413	[a] 2,572	1,366,748	11,542	2,958,958	117,080,960	101,175,455
1905	[c] 12,013,495	28,136,189	[a] 3,100	([d])	8,454	8,910,416	134,717,580	84,157,399
1906	[c] 21,718,648	12,567,897	[a] 3,500	([d])	[e] 7,000	9,077,528	126,493,936	92,444,735
1907	2,409,521	12,322,696	[a] 4,000	43,524,128	[f] 9,339	5,000,221	166,095,335	120,106,749
1908	1,801,781	11,206,464	[a] 15,246	45,798,765	[f] 17,775	5,788,874	178,527,355	129,079,184
1909	1,263,764	9,534,467	[a] 5,750	47,859,218	[f] 20,056	3,059,531	183,170,874	128,328,487
1910	1,128,668	8,899,266	[a] 3,615	52,028,718	[f] 115,430	6,841,395	209,557,248	127,899,688
1911	1,278,819	9,526,474	[a] 7,995	56,069,637	[f] 186,695	10,720,420	220,449,391	134,044,752
Total.	47,830,182	156,986,662	54,077	246,840,779	425,741	53,823,731	2,598,313,331	2,174,229,796

[a] Includes the production of Michigan.
[b] Includes production of Michigan and small production in Oklahoma.
[c] Includes production of Oklahoma.
[d] Included with Kansas.
[e] Estimated.
[f] Includes the production of Utah.

PRODUCTION BY FIELDS.

The addition of new oil regions remote and geographically quite distinct from the original Appalachian field in New York, Pennsylvania, West Virginia, eastern Ohio, and Kentucky has led to the grouping of several new regions into separate fields defined geographically. These fields are gradually approaching one another and the oils are often sold in the same market, so that the grouping often leads to confusion, which detracts seriously from any real advantage. Nevertheless, the oils are as a rule dissimilar in quality, and hence the division of territory into fields is maintained and the changes in production are shown below.

Production of petroleum in the United States, 1907–1911, by fields, in barrels.

Field.	1907	1908	1909	1910	1911
Appalachian	25,342,137	24,945,517	26,535,844	26,892,579	23,749,832
Lima-Indiana	13,121,094	10,032,305	8,211,443	7,253,861	6,231,164
Illinois	24,281,973	33,686,238	30,898,339	33,143,362	31,317,038
Mid-Continent [a]	46,896,267	48,823,747	50,833,740	58,965,865	65,917,788
Gulf	16,360,299	15,772,137	10,883,240	9,932,182	11,677,562
California	39,748,375	44,854,737	55,471,601	73,010,560	81,134,391
Other	345,190	412,674	336,667	358,839	421,616
Total	166,095,335	178,527,355	183,170,874	209,557,248	220,449,391

[a] Includes Caddo production for commercial purposes.

Percentages of total petroleum produced in the several fields, 1907–1911.

Field.	1907	1908	1909	1910	1911
Appalachian	15.26	13.97	14.49	12.83	10.77
Lima-Indiana	7.90	5.62	4.48	3.46	2.83
Illinois	14.62	18.87	16.87	15.82	14.21
Mid-Continent [a]	28.23	27.35	27.75	28.14	29.90
Gulf	9.85	8.83	5.94	4.74	5.30
California	23.93	25.13	30.29	34.84	36.80
Other	.21	.23	.18	.17	.19
Total	100.00	100.00	100.00	100.00	100.00

[a] Includes Caddo production for commercial purposes.

Production of petroleum in the United States in 1910 and 1911, by fields, showing percentage of increase or decrease, in barrels.

Field.	Production.		Increase.	Decrease.	Percentage.	
	1910	1911			Increase.	Decrease.
Appalachian	26,892,579	23,749,832		3,142,747		11.37
Lima-Indiana	7,253,861	6,231,164		1,022,697		14.10
Illinois	33,143,362	31,317,038		1,826,324		5.51
Mid-Continent [a]	58,965,865	65,917,788	6,951,923		11.79	
Gulf	9,932,182	11,677,562	1,745,380		17.57	
California	73,010,560	81,134,391	8,123,831		11.13	
Other	358,839	421,616	62,777		17.49	
Total	209,557,248	220,449,391	10,892,143		5.20	

[a] Includes Caddo production for commercial purposes.

Quantity, total value, and price per barrel received at wells for petroleum produced in the United States in 1910 and 1911, by fields, in barrels.

Field.	1910			1911		
	Quantity.	Value.	Price per barrel.	Quantity.	Value.	Price per barrel.
Appalachian	26,892,579	$35,841,749	$1.333	23,749,831	$30,830,354	$1.298
Lima-Indiana	7,253,861	5,750,104	.793	6,231,164	5,116,954	.821
Illinois	33,143,362	19,669,383	.593	31,317,038	19,734,339	.630
Mid-Continent [a]	58,965,865	23,060,834	.391	65,917,788	31,563,141	.479
Gulf	9,932,182	7,486,413	.753	11,677,562	7,720,748	.661
California	73,010,560	35,749,473	.490	81,134,391	38,719,080	.477
Other	358,839	341,732	.952	421,616	360,136	.854
Total	209,557,248	127,899,688	.610	220,449,391	134,044,752	.608

[a] Includes Caddo production for commercial purposes.

Deliveries of petroleum in the United States and purposes for which shipped in 1911, by fields, in barrels.

Field.	Total deliveries in 1911.	Delivered for—		
		Refining.	Fuel.	Other purposes.
Appalachian	53,900,795	53,859,508		[a] 41,287
Lima-Indiana	15,723,227	15,714,940	4,449	[b] 3,838
Illinois	16,773,551	16,633,351	139,970	[c] 230
Kansas and Oklahoma	55,092,193	52,889,863	1,954,819	[d] 247,511
Louisiana	8,938,432	3,519,370	5,419,062	
Texas	8,733,855	4,472,798	4,261,007	[a] 50
California	69,979,391	[e] 16,500,000	[e] 49,859,391	[f] 3,620,000
Other	426,437	225,314	200,567	[a] 556
Total in 1911	229,567,881	163,815,144	61,839,265	3,913,472
Total in 1910	229,508,619	163,225,633	61,073,798	5,209,188
Total in 1909	195,947,188	139,904,316	50,719,987	5,322,885
Total in 1908	193,459,209	147,842,110	40,370,261	5,246,838

[a] Lubricating.
[b] Road use and gas manufacture.
[c] Street use.
[d] Shipped by rail and can not be classified.
[e] Estimated.
[f] Estimated for road oil and gas manufacture.

STOCKS.

Total stocks in the United States increased from 131,030,158 barrels at the beginning of the year 1911 to 138,239,572 barrels at the end. This stock or supply of crude above ground amounts to little more than half a year's supply. The gain in California was over 11,000,000 barrels, or 4,000,000 more than the net gain for the country. The decline was greatest, nearly 7,000,000 barrels, in Illinois. A drain on stocks began late in the year in the Mid-Continent field. The stocks held by the Eastern pipe lines at the end of 1911 showed a notable decline.

Stocks, runs, and deliveries of petroleum in the United States in 1911, by fields, in barrels.

Field.	Gross stocks, Dec. 31, 1910.	Runs from wells sold or used in 1911.	Deliveries in 1911.	Gross stocks, Dec. 31, 1911.
Appalachian	9,022,152	23,749,832	53,900,975	9,494,362
Lima-Indiana	6,579,072	6,231,164	15,723,227	5,086,841
Illinois	[a] 28,084,397	31,317,038	16,773,551	[a] 21,268,247
Kansas and Oklahoma	50,035,523	57,348,456	55,092,193	[b] 51,579,819
Louisiana	[c] 1,834,775	10,720,420	8,938,432	[c] 3,689,723
Texas	[c] 2,358,840	9,526,474	8,733,855	[c] 2,855,002
California	33,085,118	81,134,391	69,979,391	[d] 44,240,118
Other	30,281	421,616	426,437	25,460
Total in 1911	131,030,158	220,449,391	229,567,881	138,239,572
Total in 1910		209,557,248	229,508,619	
Total in 1909		183,170,874	195,947,188	
Total in 1908		178,527,355	193,459,209	

[a] Includes some Indiana petroleum. Considerable of this petroleum is tanked outside of Illinois.

[b] Includes 1,396,297 barrels of petroleum tanked outside the States of Oklahoma and Kansas.

[c] In addition to this some oil was held in producers' storage and refiners' reserve.

[d] In addition there were field stocks of 1,988,952 barrels in 1909, 4,156,450 barrels in 1910, and 1,511,450 barrels in 1911, held in tanks of producers and unsold.

Grades of all stocks of petroleum held in the United States, December 31, 1910 and 1911, by fields, in barrels.

Kind of oil.	Quantity.	
	1910	1911
Pennsylvania	4,667,135	4,243,212
Lima	4,730,409	4,330,815
Illinois	31,324,784	23,171,181
Kentucky	339,310	254,763
Kansas and Oklahoma	52,659,506	55,429,298
Louisiana	1,834,775	3,689,723
Texas	2,358,840	2,855,002
California	33,085,118	44,240,118
Other	30,281	25,460
Total	131,030,158	138,239,572

Grades of gross stocks of petroleum held by the eastern pipe lines at the close of each month in 1910 and 1911, in barrels.

1910.

Month.	Pennsylvania.	Lima.	Illinois.	Kentucky.	Kansas.	Total.
January	5,336,369	3,571,056	3,340,116	391,424	4,211,372	16,850,337
February	5,310,711	3,658,944	3,138,018	443,589	4,154,958	16,706,220
March	5,518,850	4,123,514	3,637,610	485,478	3,708,114	17,473,566
April	5,316,652	4,060,064	3,210,907	444,699	3,980,841	17,013,163
May	5,064,253	4,032,069	3,148,510	454,749	4,201,836	16,901,417
June	4,878,582	4,162,912	3,724,919	492,824	3,831,823	17,091,060
July	4,934,874	4,178,995	4,187,362	441,035	3,278,392	17,020,658
August	4,868,025	4,336,561	4,141,713	415,088	2,910,205	16,671,592
September	4,874,361	4,313,575	4,066,122	436,286	2,389,235	16,079,579
October	4,625,517	4,234,383	3,455,197	376,433	2,656,302	15,347,832
November	[a] 4,480,124	4,191,373	2,996,608	397,056	2,916,672	14,981,833
December	4,542,112	4,249,750	3,240,387	339,310	2,623,983	14,995,542

[a] Includes a small quantity of Illinois oil held by Tidewater pipe line.

1911.

Month.	Pennsylvania.	Lima.	Illinois.	Kentucky.	Kansas.	Total.
January	4,486,089	4,317,176	3,860,578	389,202	2,470,264	15,523,309
February	4,535,903	4,383,561	3,998,278	420,948	2,620,841	15,959,531
March	[b] 4,531,083	4,137,870	3,941,079	380,739	3,207,799	16,198,570
April	[b] 4,312,250	4,022,961	3,141,490	338,868	3,943,466	15,759,035
May	4,349,717	3,715,138	3,193,449	376,402	3,914,373	15,549,079
June	4,541,906	3,724,478	3,744,088	390,444	3,945,624	16,346,540
July	4,198,693	3,391,321	4,076,403	342,694	3,919,604	15,928,715
August	4,071,572	3,340,094	3,986,160	368,485	4,013,834	15,780,145
September	3,758,182	3,207,021	3,558,641	295,605	4,480,605	15,300,054
October	3,523,286	3,201,968	2,444,909	320,714	4,748,492	14,239,369
November	3,471,670	3,302,854	2,657,062	235,235	4,485,792	14,152,613
December	3,493,875	2,896,458	1,902,934	254,763	3,849,479	12,397,509

[b] Includes small amount of Illinois oil.

WELL RECORD.

The following tables give the well record for the United States for 1910 and 1911, by fields:

Well record in the United States in 1910, by fields.

Field.	Wells completed.				Initial daily production, in barrels.	
	Oil.	Gas.	Dry.	Total.	Total.	Average per well.
Appalachian	3,834	881	1,103	5,818	51,822	13.5
Pennsylvania and New York	1,673	243	285	2,201	6,683	4.0
Southeastern Ohio	947	76	466	1,489	18,038	19.1
Central Ohio [a]	6	126	18	150	78	13.0
West Virginia	1,138	436	283	1,857	26,194	23.0
Kentucky	70	....	51	121	829	11.8
Lima-Indiana	785	29	124	938	15,409	19.6
Lima, Ohio	501	13	58	572	6,745	13.5
Indiana	284	16	66	366	8,664	30.5
Illinois	1,681	75	393	2,149	93,256	55.5
Mid-Continent	3,505	506	610	4,621	370,163	81.0
Kansas	85	261	82	428	1,897	22.3
Oklahoma	3,188	181	408	3,777	226,638	71.1
Northern Texas	108	16	66	190	1,683	15.6
Caddo [b]	124	48	54	226	139,945	1,128.6
Gulf	397	....	126	523	78,513	150.1
Coastal Texas	365	....	116	481	63,283	173.5
Coastal Louisiana	32	....	10	42	15,230	362.6
California	763	4	50	817	....	....
Colorado	6	....	1	7	....	....
Wyoming	47	5	15	67	....	....
Total	11,018	1,500	2,422	14,940	....	....

[a] Last four months of the year.

[b] Includes Marion County, Tex.

Well record in the United States in 1911, by fields.

Field.	Wells completed.				Initial daily production, in barrels.	
	Oil.	Gas.	Dry.	Total.	Total.	Average per well.
Appalachian	2,978	976	1,060	5,014	28,100	9.44
Pennsylvania and New York	1,491	219	297	2,007	4,912	3.29
Central and southeastern Ohio	765	403	512	1,680	10,923	14.28
West Virginia	622	351	218	1,191	10,443	16.79
Kentucky	100	3	33	136	1,822	18.22
Lima-Indiana	554	23	67	644	7,477	13.50
Lima, Ohio	480	15	32	527	6,381	13.29
Indiana	74	8	35	117	1,096	14.81
Illinois	1,061	41	263	1,365	66,851	63.01
Mid-Continent	3,796	490	686	4,972	453,907	119.58
Kansas	172	150	96	418	3,271	19.01
Oklahoma	3,294	304	489	4,087	262,333	79.64
Northern Texas	84	4	38	126	19,180	228.33
Caddo [a]	246	32	63	341	169,123	687.49
Gulf	415	50	149	614	106,885	257.55
Coastal Texas	352	33	117	502	32,740	93.01
Coastal Louisiana	63	17	32	112	74,145	1,176.90
California	963	....	104	1,067	....	....
Colorado	14	....	18	32	....	....
Wyoming and Utah	37	....	16	53	....	....
Total	9,818	1,580	2,363	13,761	....	....

[a] Includes Marion County, Tex.

FUEL OILS.

GENERAL STATEMENT.

The most important feature developed by the oil industry of 1911 has been the realization of a supply of fuel oil large enough to be reckoned on as a national asset in power production. During 1910 arguments became convincing that fuel oil was sufficiently plentiful on the Pacific coast to justify great trade and manufacturing expansion in California. Oil has been adopted as fuel on the northern transcontinental railroads for significant portions of their lines. The introduction of oil as fuel as far north as Alaska, without bringing the consumption up to the level of present production, has given assurance of permanency of the supply sufficient for the industrial needs of the whole Pacific slope.

The solution of the corresponding problem on the Atlantic coast received much encouragement in 1911 by the great development of oil supplies in Mexico. The quantity of oil which the Mexican fields are now ready to furnish is variously estimated at from 6,000,000 to 12,000,000 barrels a month. The total product was perhaps a tenth as much, the production being limited neither by supply nor demand, but by transportation facilities. The needed tank steamers are being furnished as rapidly as they can be built, and meantime the popularity which fuel oil has obtained has already led to a doubling of the market price of fuel oil.

It should be borne in mind, however, that, given a supply of tank steamers sufficient for all the oil that can now be furnished for the eastern coast, the market would probably be temporarily oversupplied. The consumers of fuel require time for the substitution of oil for coal, though the many advantages of the former are obvious.

In view of the inability of the producers to furnish fuel oil in the desired quantity, it is most fortunate that it is no longer necessary to convert oil into power by burning it under boilers. The various engines of the Diesel type, in which a great variety of oils can be injected directly into the cylinders of the internal combustion engine, have greatly raised the efficiency of oil for power; but this same revolution in method of burning involves changes in construction of the engine, which will require time for introduction.

RAILROADS.

The following table of railroad consumption of fuel oil is given because it is practicable to present sufficiently accurate statistics to show the marked gain in each recent year, and because this use is especially popular because of the added comforts from freedom from coal cinders, because of avoiding the danger of forest fires, and particularly because of the saving in labor. In fact, the weight of trains where coal is burned on mountain divisions is limited by the endurance of the fireman, until the coal can be replaced by oil. In recommending the adoption of fuel oil on the mountain divisions of the Canadian Pacific Railway, William White, second vice president, states that one of the reasons for this change is the removal of danger from conflagrations in the great forests of British Columbia. He also alludes to the failure of the immense locomotives now in use, saying: "It is not the failure of the locomotives; it is the failure of the fireman." A fireman shoveling coal on one of these locomotives for a distance of 130 miles is physically exhausted before getting to the end of the run. The Southern Pacific uses over 1,200 oil-burning locomotives; the Santa Fe over 800; the Northern Pacific, 20; and the Great Northern, 115.

Thus far in locomotive use oil has simply replaced coal under boilers, but within the last year a locomotive has been constructed in Switzerland on the Diesel principle and is being subjected to thorough practical tests.

Consumption of fuel oil by the railroads of the United States, 1906–1911.

Year.	Length of line operated by the use of fuel oil.[a]	Quantity of fuel oil consumed by railroads.	Total mileage made by oil-burning engines.	Average number of miles per barrel of oil consumed.
	Miles.	*Barrels.*	*Miles.*	*Miles.*
1906		15,577,677		
1907	13,573	18,849,803	74,079,726	3.93
1908	15,474	16,870,882	64,279,509	3.81
1909	17,676	19,905,335	72,918,118	3.66
1910	22,709	23,817,346	89,107,883	3.74
1911	27,368	27,774,821	104,270,964	3.75

[a] Some of these lines also used coal.

The following are the names of the railroad companies which used fuel oil on their lines in 1911: The Sunset Lines of California, Texas, and Louisiana, embracing the Southern Pacific Co. (Pacific System, excluding the Sonora Railway), the Oregon Railroad & Navigation Co., the Oregon Short Line Railroad, the Galveston, Harrisburg & San Antonio Railway Co., the Texas & New Orleans Railroad Co., the Houston & Texas Central Railroad Co., the Houston East & West Texas Railway, the Houston & Shreveport Railroad, and the Louisiana Western Railroad; the Frisco lines, including the St. Louis & San Francisco Railroad Co. in Missouri, Kansas, Texas, and Oklahoma, the St. Louis, San Francisco & Texas Railroad, and the St. Louis, Brownsville & Mexico Railway in Texas; the New Orleans, Texas & Mexico Railroad; the Chicago, Rock Island & Pacific Railway in Kansas and Oklahoma; the Atchison, Topeka & Santa Fe Railway Co.; the Kansas City Southern Railway, in Texas and Louisiana; the International & Great Northern Railroad Co., in Texas; the San Pedro, Los Angeles & Salt Lake Railroad; the Trinity & Brazos Valley Railway Co., in Texas; the Galveston, Houston & Henderson Railroad in Texas; the San Antonio & Aransas Pass Railway Co., in Texas; the Texas & Pacific Railway Co., in Texas; the Chicago & North Western Railway Co. and the Wyoming & Northwestern Railway Co., in Wyoming; the Northern Pacific Railway Co., in Washington; the Great Northern Railway Co.; the Chicago, Milwaukee & Puget Sound Railway Co.; the Tonopah & Goldfield Railroad Co., in Nevada; and the New York Central & Hudson River Railroad in the Adirondacks, New York.

MANUFACTURES.

The quantity of oil used as fuel in manufacturing and other industries can not be computed with satisfactory accuracy, but it is estimated that, including railroad use, nearly 50,000,000 barrels of the California oil went for fuel. In Texas and Louisiana the fuel oil used is estimated at 9,000,000 barrels, much of which was in the form of residues after light distillates were taken off. In the Mid-Continent field, also, crude oil as fuel is fast giving place to these "topped" oils. Of this material about 2,000,000 barrels was consumed. Little oil from the eastern fields finds use as fuel as the heavy residuum is valuable for manufacture into lubricants, paraffin wax, etc. In all nearly 62,000,000 barrels were probably consumed as fuel oil in 1911 in the United States; a fair estimate of the consumption for the preceding year is 61,000,000 barrels, the increase showing a growing appreciation of oil as fuel.

The chief use of gasoline is as internal combustion fuel, and the quantity of this material used will be referred to elsewhere.

UNITED STATES NAVY AND MERCHANT MARINE.

The third interesting use of fuel oil is for water navigation. In this the advance in 1911 was world-wide.

Experience with fuel oil in the United States Navy has been so satisfactory that its use will be extended as rapidly as is permitted by considerations of supply and cost. Already the Navy has 19 oil-burning torpedo-boat destroyers, and 8 battleships which burn oil as auxiliary to coal. The battleships *Nevada* and *Oklahoma*, now under construction, will burn oil exclusively.

During the year 1911 the Navy used 15,000,000 gallons of fuel oil, and it is estimated that the consumption for the present year will be 21,000,000 gallons. Oiling stations of 700,000 gallons capacity have been established at Bradford, R. I., Norfolk, Va., Charleston, S. C., and Key West, Fla. A station of this size is being constructed at Guantanamo, Cuba. At each of these stations provision has been made for a considerable increase in tankage.

The only naval oil tanker at present in service is the *Arethusa*, with a capacity of 1,400,000 gallons. Each of the Navy's five most recent colliers, however, has provision for carrying 375,000 gallons of oil, and future fuel vessels built for the Navy will probably be oil tankers rather than colliers.

In the merchant marine the event of interest was the voyage of the *Honolulan* from Baltimore, Md., to Seattle, Wash., carrying a cargo of 7,000 tons of coal but propelled by oil. The journey covered 14,000 miles and required a barrel of oil per mile. That is, 7,000 tons of coal were moved 1 mile by one barrel of oil. The oil weighed 1,866 short tons, and to serve the same purpose it is estimated that 5,600 tons of coal would have been needed.

Heavy oil engines.—The heavy oil engine of the Diesel type continues to develop and its extensive adoption for marine service within comparatively few years seems probable. The 12 most recent submarines will have Diesel engines of from 300 to 450 horsepower; the submarine tender *Niagara* will have an engine of 900 horsepower; and a 150-horsepower engine of this type is being installed in a 50-foot cutter for experimental purposes.

The application of Diesel engines to tank and other freight vessels and even to passenger craft was extended to a point where the expression "steamer" is no longer strictly correct, and a new term will be required for distinction between sailing vessels and those propelled by engines.

The most significant achievement of fuel oil in engine ships was the voyage of the Danish East Asiatic Co.'s Diesel ship *Selandia*, which crossed from Copenhagen to London in March, 1912, on her maiden voyage to Bangkok, Siam. The *Selandia* is of 7,000 tons and is propelled by two Diesel engines of 1,200 horsepower each. All auxiliary machinery such as cargo winches, and electric-light plant are driven by additional Diesel engines. There are, of course, no smoke funnels. The coal bunker room is saved, and most of the boiler space, though the space occupied by the engine is slightly greater than when steam engines are used. The oil carried is 1,000 tons, of which a ton is burned in two hours under full speed. Two larger Diesel ships have been ordered by the same line.

SMELTERS.

California crude oil has been used for some time in reverberatory furnaces at McGill, Nev., and Cananea, Mexico. Early in 1911 arrangements were made for the use of oil in the smelter of the Ray Consolidated Co., at Ray, Ariz., and in the copper smelter at Steptoe, Nev., of the Nevada Consolidated Mining Co. At the Van Anda smelter on Vancouver Island satisfactory experiments have been carried out with California oil fuel.

PETROLEUM OPERATORS' STATISTICS.

The results given in the tables below are of statistics collected directly from the oil producers. The object of this investigation in addition to determining the production by the pipe-line statistics is to avoid by this double system any serious errors by either method. The results have fully justified the additional labor, and have been especially useful in distributing the product to the producing States. It is the only means by which track is kept of the total number of wells producing in the United States and of the acres under development.

Production and value of petroleum, well records, and acreage for the United States in 1910, by States, from statistics furnished by the producers.

State.	Production (in barrels).			Value.	Average price per barrel.	Stock at wells (in barrels).		Wells.						Average daily production (in barrels) per well.	Acreage.		
	Placed to credit of—		Total.			Jan. 1.	Dec. 31.	Productive Jan. 1.	Completed.		Abandoned.	Productive Dec. 31.	Drilling Dec. 31.		Fee.	Lease.	Total.
	Producer.	Land-owner.							Oil.	Dry.							
California	a63,884,240	a9,126,320	73,010,560	$35,749,473	$0.490	1,988,952	4,156,450	4,447	840	50	99	5,188	661	38.6	b232,506	384,185	616,691
Colorado	a209,820	a29,974	239,794	243,402	1.015	....	....	112	6	1	2	116	8	5.7	11,575	67,192	78,767
Illinois	27,740,228	4,381,412	32,121,640	18,911,045	.589	756,661	548,884	11,152	1,404	214	385	12,171	50	7.2	3,384	405,195	408,579
Indiana	1,436,829	212,731	1,649,560	1,200,660	.728	55,974	46,268	8,056	139	16	1,702	6,493	11	.7	3,494	123,451	126,945
Kansas	963,108	111,994	1,075,102	432,638	.402	17,416	17,949	1,831	53	26	97	1,787	4	1.6	9,651	101,589	111,240
Kentucky	397,199	49,592	446,791	320,009	.716	9,187	5,415	1,001	49	52	62	988	8	1.2	3,678	132,435	136,113
Louisiana	5,978,362	1,072,153	7,050,575	3,686,132	.523	69,084	52,998	198	160	48	40	318	27	60.7	11,991	970,042	982,033
Michigan	a3,163	a452	3,615	4,794	1.326	....	....	20	6	6	....	26	....	.4	815	5,115	5,930
Missouri																	
New York	988,567	87,418	1,075,985	1,432,592	1.331	12,157	13,511	10,931	135	4	192	10,874	2	.3	38,690	70,253	108,943
Ohio	7,255,759	1,109,398	8,365,157	8,727,860	1.043	141,154	132,137	32,156	822	197	1,723	31,255	66	.7	29,659	655,327	684,986
Oklahoma	41,862,570	5,658,614	47,521,184	18,408,419	.387	5,608,381	6,449,286	11,887	2,194	203	479	13,602	91	9.6	23,056	1,282,825	1,305,881
Pennsylvania	7,043,295	764,732	7,808,027	10,543,810	1.354	111,022	103,438	50,900	887	104	796	50,991	27	.4	229,388	797,546	1,026,934
Texas	6,014,078	528,336	6,542,414	4,740,781	.725	58,122	94,137	2,377	312	128	182	2,507	16	7.1	56,188	703,254	759,442
Utah	a101,001	a14,429	115,430	93,536	.810	....	....	17	....	....	6	11	16	2.6	c9,910	520	10,430
Wyoming								107	15	15	10	112	18		14,460	30,250	44,710
West Virginia	9,666,839	1,334,033	11,000,872	14,460,278	1.314	186,331	158,354	12,835	702	140	573	12,964	144	2.3	31,706	2,689,188	2,720,894
Total	173,545,058	24,481,588	198,026,646	118,955,429	.601	9,014,441	11,778,827	148,027	7,724	1,204	6,348	149,403	1,149	3.6	710,151	8,418,367	9,128,518

[a] Estimated.

[b] Includes 70,194 acres of oil locations.

[c] Includes 200 acres of oil locations.

Production and value of petroleum, well records, and acreage for the United States in 1911, by States, from statistics furnished by producers.

State.	Production (in barrels).			Value.	Average price per barrel.	Wells.					Average daily production (in barrels) per well.	Acreage.		
	Placed to credit of—		Total.			Productive Jan. 1.	Completed.		Abandoned.	Productive Dec. 31.		Fee.	Lease.	Total.
	Producer.	Landowner.					Oil.	Dry.						
California	77,140,431	3,993,960	81,134,391	$38,719,080	$0.477	5,188	963	104	246	5,905	38.1	326,009	237,552	563,561
Colorado	222,957	3,969	226,926	228,104	1.005	116	14	18	9	121	5.1	13,230	20,140	33,370
Illinois	25,873,928	4,734,235	30,608,163	19,505,303	.637	12,171	969	160	387	12,753	4.2	4,033	314,338	318,371
Indiana	1,106,358	173,143	1,279,501	886,488	.693	6,493	167	10	1,533	5,127	.7	a 3,494	123,451	126,945
Kansas	1,089,890	137,842	1,227,732	626,431	.510	1,787	164	25	194	1,757	1.9	10,031	110,199	120,230
Kentucky	385,856	47,986	433,842	302,651	.698	988	91	38	91	988	1.2	a 3,678	132,435	136,113
Louisiana	10,356,642	1,892,988	12,249,630	6,317,559	.516	318	302	84	65	555	60.5	24,570	815,791	840,361
Michigan Missouri	7,795	200	7,995	7,995	1.000	26	1	3	....	27	.8	815	5,115	5,930
New York	868,621	71,106	939,727	1,248,886	1.329	10,874	147	9	396	10,625	.2	a 38,690	70,253	108,943
Ohio	6,464,111	1,004,135	7,468,246	7,567,069	1.013	31,255	1,671	289	1,589	31,337	.7	a 29,659	655,327	684,986
Oklahoma	42,016,485	6,192,090	48,208,575	23,304,883	.485	13,602	2,378	319	682	15,298	8.6	40,621	1,147,969	1,188,590
Pennsylvania	6,763,085	727,659	7,490,744	9,896,604	1.321	50,991	2,835	202	1,281	52,545	.4	a 229,388	797,546	1,026,934
Texas	7,524,926	897,482	8,422,408	5,540,876	.658	2,507	459	124	494	2,472	9.3	26,415	362,929	389,344
Utah	172,989	13,706	186,695	124,037	.664	11	1	7	....	12	3.1	16,000	2,740	18,740
Wyoming						112	45	9	6	151		12,220	27,330	39,550
West Virginia	8,347,518	1,166,046	9,513,564	12,375,618	1.301	12,964	664	143	614	13,014	2.0	a 31,706	2,689,188	2,720,894
Total	188,341,592	21,056,547	209,398,139	126,651,584	.604	149,403	10,871	1,544	7,587	152,687	3.8	810,559	7,512,303	8,322,862

a Data for 1910.

The following tables give the well records of the petroleum industry in 1910 and 1911 for the respective States by counties:

Petroleum well record in 1910 and 1911, by counties.

NEW YORK.

County.	1910					1911			
	Productive Jan. 1.	Completed.		Abandoned.	Productive Dec. 31.	Completed.		Abandoned.	Productive Dec. 31.
		Oil.	Dry.			Oil.	Dry.		
Allegany	7,802	118	4	136	7,784	114	8	278	7,620
Cattaraugus	2,911	16	....	56	2,871	33	1	117	2,787
Steuben	218	1	....	....	219	....	....	1	218
Total	10,931	135	4	192	10,874	147	9	396	10,625

PENNSYLVANIA.

County.	1910					1911			
	Productive Jan. 1.	Completed.		Abandoned.	Productive Dec. 31.	Completed.		Abandoned.	Productive Dec. 31.
		Oil.	Dry.			Oil.	Dry.		
Allegheny	1,728	69	10	54	1,743	191	24	94	1,840
Armstrong	171	9	3	2	178	10	2	9	179
Beaver	629	4	3	20	613	31	5	51	593
Butler	5,493	74	22	216	5,351	120	50	555	4,916
Clarion	1,644	72	10	20	1,696	138	24	42	1,792
Crawford	500	10	....	3	507	115	....	6	616
Elk	1,063	15	....	....	1,078	47	....	9	1,116
Forest	1,512	22	6	33	1,501	172	15	40	1,633
Greene	433	18	12	23	428	70	9	14	484
Jefferson	125	1	....	....	126	7	....	2	131
Lawrence	9	24	2	....	33	35	1	....	68
McKean	14,571	142	5	83	14,630	531	10	106	15,055
Mercer	267	4	....	....	271	2	....	7	266
Potter	159	....	....	10	149	6	....	70	85
Tioga	45	....	....	4	41	....	....	15	26
Venango	14,421	328	14	216	14,533	736	39	70	15,199
Warren	6,308	82	15	42	6,348	618	18	60	6,906
Washington	1,822	13	2	70	1,765	6	5	131	1,640
Total	50,900	887	104	796	50,991	2,835	202	1,281	52,545

WEST VIRGINIA.

County.	1910					1911			
	Productive Jan. 1.	Completed.		Abandoned.	Productive Dec. 31.	Completed.		Abandoned.	Productive Dec. 31.
		Oil.	Dry.			Oil.	Dry.		
Braxton	....	....	....	....	....	1	....	....	1
Brooke	360	3	4	8	355	1	2	30	326
Cabell	29	2	....	5	26	2	4	5	23
Calhoun	267	4	....	6	265	10	1	1	274
Clay	....	....	....	....	....	4	1	1	3
Doddridge	576	24	14	13	587	9	2	42	554
Gilmer	87	9	2	12	84	....	....	1	83
Hancock	318	10	2	8	320	7	10	27	300
Harrison	1,089	70	24	16	1,143	52	11	47	1,148
Kanawha	....	....	....	....	....	13	3	8	5
Lewis	232	14	....	15	231	2	4	9	224
Lincoln	328	121	1	11	438	57	....	2	493
Logan	....	....	....	....	....	2	3	....	2
Marion	683	37	2	48	672	16	2	48	640
Marshall	208	7	....	18	197	....	....	30	167
Mason	....	....	....	....	....	....	2	....	....
Monongalia	772	13	2	40	745	8	5	76	677
Ohio	....	....	1	....	....	4	....	....	4
Pleasants	1,634	40	14	66	1,608	52	16	47	1,613
Putnam	1	....	1	1	....	....	....	....	....
Ritchie	1,843	80	22	54	1,869	48	38	116	1,801
Roane	418	132	11	2	548	177	4	11	714
Taylor	....	....	....	....	....	....	1	....	....
Tyler	1,660	67	18	117	1,610	19	18	52	1,572
Upshur	....	....	....	....	....	....	2	....	....
Wayne	....	2	1	....	2	....	....	....	2
Wetzel	1,245	13	....	83	1,175	59	3	38	1,196
Wirt	347	21	6	8	360	81	11	10	431
Wood	738	33	15	42	729	40	....	13	756
Total	12,835	702	140	573	12,964	664	143	614	13,014

Petroleum well record in 1910 and 1911, by counties—Continued.

KENTUCKY.

County.	1910					1911			
	Productive Jan. 1.	Completed.		Abandoned.	Productive Dec. 31.	Completed.		Abandoned.	Productive Dec. 31.
		Oil.	Dry.			Oil.	Dry.		
Barren	9				9			2	7
Bath	91				91				91
Boyd							2		
Floyd	18				18	1	2		19
Knott	1				1	1	1		2
Lawrence		3	2	3		11	1	1	10
Logan	5	2	2		7			2	5
Rowan	35				35				35
Wayne	696	44	48	55	685	76	32	73	688
Wolfe	146			4	142	2		13	131
Total	1,001	49	52	62	988	91	38	91	988

OHIO.

County.	1910					1911			
	Productive Jan. 1.	Completed.		Abandoned.	Productive Dec. 31.	Completed.		Abandoned.	Productive Dec. 31.
		Oil.	Dry.			Oil.	Dry.		
Allen	2,159	16		245	1,930	25	1	152	1,803
Athens	120	1			121	8		8	121
Auglaize	613	28	1	37	604	9		52	561
Belmont	199	2	2	16	185	10	2	10	185
Carroll	22	25	14	2	45	3		5	43
Columbiana	299	12	12	2	309	14	2	32	291
Coshocton	12	1	2		13	4	4		17
Fairfield	113	68	9	4	177	73	12	8	242
Guernsey	9	1	4		10	1	1	1	10
Hancock	3,819	43		196	3,666	59	6	432	3,293
Harrison	837	20	8	68	789	93	11	10	862
Hocking		2			2	20	1	2	20
Holmes	23	3		3	23	6	1	1	28
Jackson	12	5			17			3	14
Jefferson	345	30	29	21	354	82	23	10	426
Knox	10	1		3	8			2	6
Licking						1	1		1
Logan						1	1	1	
Lorain	9				9				9
Lucas	601	8	3	30	579	22	2	71	530
Mahoning						2	2	2	
Medina		3			3				3
Mercer	907			96	811	8	1	117	702
Monroe	2,543	55	23	95	2,503	105	42	21	2,587
Morgan	672	35	12	75	632	105	31	17	720
Muskingum	158	1	2	2	157	8	2	3	162
Noble	376	24	6	22	378	50	16	4	424
Ottawa	464	10	3	40	434	85	4	11	508
Perry	172	72	19	9	235	93	14	8	320
Ross		1		1					
Sandusky	4,540	39	4	112	4,467	41	3	413	4,095
Seneca	635	8	2	20	623	64	8	15	672
Shelby	32			6	26			4	22
Trumbull	15		3	2	13	4	1	1	16
Tuscarawas	4			1	3		2	3	
Van Wert	813	27		50	790	69	1	17	842
Vinton	14	5	2	3	16	1		2	15
Washington	3,508	213	17	97	3,624	416	83	89	3,961
Wood	7,929	63	20	430	7,562	187	11	30	7,719
Wyandot	172			35	137	2		32	107
Total	32,156	822	197	1,723	31,255	1,671	289	1,589	31,337

Petroleum well record in 1910 and 1911, by counties—Continued.

INDIANA.

County.	1910					1911			
	Productive Jan. 1.	Completed.		Abandoned.	Productive Dec. 31.	Completed.		Abandoned.	Productive Dec. 31.
		Oil.	Dry.			Oil.	Dry.		
Adams	1,020	16		133	903	10		184	729
Blackford	449			120	329			90	239
Daviess							1		
Delaware	238			40	198	9	2	43	164
Gibson	162			10	152			37	115
Grant	2,180			719	1,461			611	850
Huntington	687			115	572	1		81	492
Jay	868	50	8	29	889	45		22	912
Pike	35	65	5	4	96	71	4	9	158
Randolph	45	5	2	7	43	2		6	39
Sullivan	4	2			6				6
Vigo	8				8				8
Wells	2,350			525	1,825	28	2	440	1,413
Miscellaneous [a]	10	1	1		11	1	1	10	2
Total	8,056	139	16	1,702	6,493	167	10	1,533	5,127

ILLINOIS.

County.	1910								
	Wells						Acreage.		
	Productive Jan. 1.	Completed.		Abandoned.	Productive Dec. 31.	Drilling Dec. 31.	Fee.	Lease.	Total.
		Oil.	Dry.						
Clark	2,416	49	12	124	2,341		1,065	58,515	59,580
Coles	65	3		1	67		140	575	715
Crawford	6,068	801	113	217	6,652	15	913	102,737	103,650
Cumberland	649	32	5	4	677			6,221	6,221
Edgar	7			1	6		530	80	610
Jersey			4						
Lawrence	1,937	512	72	38	2,411	30	329	80,615	80,944
Macoupin						1		23,793	23,793
Madison			4					11,486	11,486
Marion	5	7	4		12	4		35,920	35,920
Randolph	5				5		407	493	900
Miscellaneous (undeveloped)								84,760	84,760
Total	11,152	1,404	214	385	12,171	50	3,384	405,195	408,579

County.	1911							
	Wells.					Acreage.		
	Productive Jan. 1.	Completed.		Abandoned.	Productive Dec. 31.	Fee.	Lease.	Total.
		Oil.	Dry.					
Bond			6				20,276	20,276
Clark	2,341	48	15	135	2,254	1,503	53,688	55,171
Clinton		111	33	1	110		39,893	39,893
Coles	67	1		14	54		625	625
Crawford	6,652	272	56	71	6,853	1,411	69,384	71,295
Cumberland	677	4	1	19	662	19	6,185	6,204
Edgar	6	4	2	4	6	470	230	700
Lawrence	2,411	497	40	139	2,769	288	75,484	75,772
Macoupin		1	1		1		6,873	6,873
Madison		1			1	342	8,498	8,840
Marion	12	29	5	1	40		19,479	19,479
Randolph	5	1		3	3		778	778
Richland			1				20	20
Miscellaneous (undeveloped)							12,445	12,445
Total	12,171	969	160	387	12,753	4,033	314,338	318,371

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[a] Includes Greene, Hamilton, and Perry counties and undeveloped leases.

Petroleum well record in 1910 and 1911, by counties—Continued.

KANSAS.

County.	1910								
	Wells.						Acreage.		
	Productive Jan. 1.	Completed.		Abandoned.	Productive Dec. 31.	Drilling Dec. 31.	Fee.	Lease.	Total.
		Oil.	Dry.						
Allen	156	9	18	5	160	2	1,017	7,529	8,546
Chautauqua [a]	785	34	3	45	774	2	4,125	30,447	34,572
Franklin	25				25			327	327
Miami	34			1	33		3	371	374
Montgomery	450	8		27	431		324	30,015	30,339
Neosho [b]	185	2	5	16	171		610	12,502	13,112
Wilson	196			3	193		3,572	20,398	23,970
Total	1,831	53	26	97	1,787	4	9,651	101,589	111,240

County.	1911							
	Wells.					Acreage.		
	Productive Jan. 1.	Completed.		Abandoned.	Productive Dec. 31.	Fee.	Lease.	Total.
		Oil.	Dry.					
Allen	160	46	11	36	170	613	8,465	9,078
Chautauqua	767	53	4	54	766	5,967	36,911	42,878
Coffey	2				2		240	240
Elk	5			1	4		150	150
Franklin	25	1			26		77	77
Labette	1				1			
Miami	33			9	24	32	391	423
Montgomery	431	38	3	58	411	851	45,307	46,158
Neosho	170	26	1	13	183	1,050	3,798	4,848
Wilson	193		6	23	170	1,518	14,860	16,378
Total	1,787	164	25	194	1,757	10,031	110,199	120,230

OKLAHOMA.

County.	1910								
	Wells.						Acreage.		
	Productive Jan. 1.	Completed.		Abandoned.	Productive Dec. 31.	Drilling Dec. 31.	Fee.	Lease.	Total.
		Oil.	Dry.						
Atoka	4				4	10		6,000	6,000
Carter	23	12	2		35	1	1,830	6,482	8,312
Cherokee	32	5			37			530	530
Comanche	3				3	1		10,500	10,500
Craig	1				1		10	300	310
Creek	1,595	253	10	19	1,829	23	1,138	48,507	49,645
Johnston		1	6		1	1		1,140	1,140
Kiowa	5				5			1,120	1,120
Marshall	9	2	1	8	3		30	18,221	18,251
Muskogee	157	89	16	17	229	8	1,014	16,360	17,374
Nowata	4,171	657	44	202	4,626	10	5,111	74,580	79,691
Okmulgee	134	76	15	4	206	1	5,685	48,142	53,827
Osage	984	220	46	25	1,179	13		487,067	487,067
Pawnee	201	5	2	17	189		327	9,166	9,493
Pittsburg	4	3	4		7	7		3,855	3,855
Rogers	1,517	199	16	73	1,643	3	1,890	21,578	23,468
Sequoyah			1					4,000	4,000
Tulsa	823	215	16	28	1,010		1,280	39,555	40,835
Wagoner	1				1			3,847	3,847
Washington	2,223	457	23	86	2,594	13	4,741	445,227	449,968
Miscellaneous (undeveloped)								36,648	36,648
Total	11,887	2,194	203	479	13,602	91	23,056	1,282,825	1,305,881

[a] Includes Elk and Coffey counties.

[b] Includes Labette County.

Petroleum well record in 1910 and 1911, by counties—Continued.

OKLAHOMA—Continued.

County.	1911							
	Wells.					Acreage.		
	Productive Jan. 1.	Completed.		Abandoned.	Productive Dec. 31.	Fee.	Lease.	Total.
		Oil.	Dry.					
Atoka	4		10	4			3,500	3,500
Carter	35	7			42	1,830	8,902	10,732
Cherokee	37	1	2	7	31		230	230
Comanche	3		1		3		15,700	15,700
Craig	1			1			300	300
Creek	1,829	98	37	174	1,753	4,188	89,942	94,130
Jackson	1		1	1			5	5
Jefferson		2	5	2		3,700	12,300	16,000
Johnston			5				1,780	1,780
Kay		4	7		4		4,000	4,000
Kiowa	5				5		660	660
Le Flore			2				13,488	13,488
Marshall	3	1		1	3	30	5,669	5,699
Muskogee	229	72	21	16	285	863	28,073	28,936
Nowata	4,626	242	35	191	4,677	5,644	75,124	80,768
Okfuskee			1				12,571	12,571
Okmulgee	206	53	16	15	244	5,015	79,148	84,163
Osage	1,179	461	44	47	1,593	1,970	180,114	182,084
Pawnee	189	141	12	13	317	255	32,353	32,608
Pittsburg	7		1	7			2,015	2,015
Rogers	1,643	142	10	22	1,763	1,999	21,972	23,971
Sequoyah			1				3,000	3,000
Stephens			1				4,680	4,680
Tulsa	1,010	358	29	62	1,306	3,695	70,246	73,941
Wagoner	1			1			3,692	3,692
Washington	2,594	796	78	118	3,292	7,224	433,343	440,567
Miscellaneous (undeveloped)						4,208	45,162	49,370
Total	13,602	2,378	319	682	15,298	40,621	1,147,969	1,188,590

TEXAS.

County.	1910								
	Wells.						Acreage.		
	Productive Jan. 1.	Completed.		Abandoned.	Productive Dec. 31.	Drilling Dec. 31.	Fee.	Lease.	Total.
		Oil.	Dry.						
Bexar	5				5			1,947	1,947
Brazoria	3	2	4	1	4	2	40,000		40,000
Brewster			1					10,000	10,000
Brown	5				5		40		40
Clay	150	15	17	2	163	2	5,744	416,355	422,099
Coleman	1				1			8,000	8,000
Dallas	3	3		3	3		4		4
Denton			2					3,000	3,000
Duval	4				4			250	250
Hardin	793	119	31	92	820		3,066	2,391	5,457
Harris	299	57	17	26	330	3	866	19,138	20,004
Henderson			2					5,000	5,000
Jefferson	122	34	14	30	126	2	89	1,142	1,231
Kaufman			3						
Lamar			2			1		25,000	25,000
Liberty	8		2	5	3		5	2,662	2,667
McLennan	12				12			360	360
McMullen	16				16			7,000	7,000
Marion		6	3		6		3,131	19,380	22,511
Matagorda	4	12	1	3	13	3	80	1,141	1,221
Navarro	952	63	25	20	995	1	2,193	63,794	65,987
Nueces			1					3,000	3,000
Reeves		1	1		1	1	850	9,000	9,850
Shelby			1						
Starr						1		14,000	14,000
Walker			1					2,500	2,500
Miscellaneous (undeveloped)							120	88,194	88,314
Total	2,377	312	128	182	2,507	16	56,188	703,254	759,442

Petroleum well record in 1910 and 1911, by counties—Continued.

TEXAS—Continued.

County.	1911							
	Wells.					Acreage.		
	Productive Jan. 1.	Completed.		Abandoned.	Productive Dec. 31.	Fee.	Lease.	Total.
		Oil.	Dry.					
Bexar	5			2	3	597	375	972
Brazoria	4		6		4	3,000	700	3,700
Brewster			1					
Brown	5	1			6	500		500
Clay	163	18	2	30	151	5,538	41,346	46,884
Coleman	1	1		1	1		8,200	8,200
Dallas	3			3				
Denton		2		2			3,000	3,000
Duval	4		3	3	1	84	700	784
Fannin			2					
Fort Bend			1				4,204	4,204
Gregg			1				5,000	5,000
Hardin	820	138	28	113	845	3,690	2,282	5,972
Harris	330	131	38	56	405	855	17,176	18,031
Jefferson	126	16	7	42	100	100	1,147	1,247
Liberty	3	5		3	5	10	2,044	2,054
McLennan	12		1		12	80	365	445
McMullen	16	3			19		7,000	7,000
Marion	6	6	4		12	2,570	15,562	18,132
Matagorda	13	20	7	3	30	1	1,369	1,370
Navarro	995	37	2	235	797	3,128	39,284	42,412
Rush			1			1,250	3,369	4,619
Reeves	1		4	1		2,773		2,773
Robertson		1	1		1		5,000	5,000
Smith			1				2,950	2,950
Starr			1					
Walker			2				2,583	2,583
Waller			1					
Wichita		58			58	342	108,541	108,883
Wilbarger		22	7		22	17	7,150	7,167
Wilson			1			80	14,600	14,680
Miscellaneous (undeveloped)			2			1,800	68,982	70,782
Total	2,507	459	124	494	2,472	26,415	362,929	389,344

LOUISIANA.

Parish.	1910								
	Wells.						Acreage.		
	Productive Jan. 1.	Completed.		Abandoned.	Productive Dec. 31.	Drilling Dec. 31.	Fee.	Lease.	Total.
		Oil.	Dry.						
Acadia	98	19	5	26	91	3	641	1,766	2,407
Bossier						1			
Caddo	87	131	30	11	207	22	7,804	220,486	228,29
Calcasieu	9	10	10	1	18		2,346	1,734	4,08
St. Martin	4		1	2	2	1		50	5
St. Tammany			2					40,000	40,00
Miscellaneous (undeveloped)							1,200	706,006	707,20
Total	198	160	48	40	318	27	11,991	970,042	982,03

Petroleum well record in 1910 and 1911, by counties—Continued.

LOUISIANA—Continued.

Parish.	1911							
	Wells.					Acreage.		
	Productive Jan. 1.	Completed.		Abandoned.	Productive Dec. 31.	Fee.	Lease.	Total.
		Oil.	Dry.					
Acadia	91	9	1	18	82	742	1,766	2,508
Caddo	207	257	44	31	413	20,022	631,674	651,696
Calcasieu	18	53	29	13	58	556	3,319	3,875
Natchitoches			1				24,000	24,000
Sabine			2				45,436	45,436
St. Landry			3			1,000	9,115	10,115
St. Martin	2	2	1	2	2		37	37
St. Tammany			2				2,000	2,000
Terrebonne		1		1				
West Feliciana			1				50,000	50,000
Miscellaneous (undeveloped)						2,250	48,444	50,694
Total	318	302	84	65	555	24,570	815,791	840,361

APPALACHIAN OIL FIELD.

PRODUCTION.

The Appalachian oil field embraces the region extending from New York slightly west of south through Pennsylvania, West Virginia, southeastern Ohio, and Kentucky into Tennessee.

Instead of the slight net increase shown in 1910, there was a decline in New York, Pennsylvania, West Virginia, and southeastern Ohio, though Kentucky showed a very small increase. The statistics are detailed in the tables which follow.

Production of the Appalachian oil field, by States and months, in 1911, in barrels.

Month.	Pennsylvania.	New York.	Southeastern Ohio.	West Virginia.	Kentucky.	Total.
January	697,254	83,160	346,170	814,743	33,237	1,974,564
February	637,683	73,007	341,747	800,712	31,151	1,884,300
March	722,719	83,226	372,270	881,172	37,910	2,097,297
April	701,453	81,239	345,162	810,661	35,484	1,973,999
May	765,434	88,594	383,774	882,093	42,906	2,162,801
June	704,047	84,442	371,118	832,920	38,509	2,031,036
July	668,289	75,885	341,329	787,171	42,237	1,914,911
August	704,591	81,368	364,138	838,922	44,087	2,033,106
September	661,739	76,263	352,353	773,024	44,356	1,907,735
October	690,324	78,469	358,100	795,687	41,556	1,964,136
November	622,507	70,101	343,691	757,029	40,818	1,834,146
December	671,688	76,761	361,385	821,330	40,207	1,971,371
Total	8,248,158	952,515	4,281,237	9,795,464	472,458	23,749,832

The production of petroleum in the Appalachian oil field from 1859 to 1911, inclusive, is given in the following table:

Production of petroleum in the Appalachian field, 1859–1911, in barrels.

Year.	Production.	Per cent of total production.	Increase (+) or decrease (−) from previous year.	Yearly average price per barrel.[a]
1859	2,000	100	....	$16.00
1860	500,000	100	+ 498,000	9.59
1861	2,113,609	100	+1,613,609	.49
1862	3,056,690	100	+ 943,081	1.05
1863	2,611,309	100	+ 445,381	3.15
1864	2,116,109	100	− 495,200	8.06
1865	2,497,700	100	+ 381,591	6.59
1866	3,597,700	100	+1,100,000	3.74
1867	3,347,300	100	− 250,400	2.41
1868	3,646,117	100	+ 298,817	3.62½
1869	4,215,000	100	+ 568,883	5.63¾
1870	5,260,745	100	+1,045,745	3.86
1871	5,205,234	100	− 55,511	4.34
1872	6,293,194	100	+1,087,960	3.64
1873	9,893,786	100	+3,600,592	1.83
1874	10,926,945	100	+1,033,159	1.17
1875	8,787,514	100	−2,139,431	1.35
1876	9,120,669	99.87	+ 333,155	2.56¼
1877	13,337,363	99.90	+4,216,694	2.42
1878	15,381,641	99.90	+2,044,278	1.19
1879	19,894,288	99.90	+4,512,647	.85⅞
1880	26,245,571	99.85	+6,351,283	.94½
1881	27,561,376	99.64	+1,315,805	.85⅞
1882	30,221,261	99.58	+2,659,885	.78⅛
1883	23,306,776	99.39	−6,914,485	1.05¾
1884	23,956,438	98.92	+ 649,662	.83½
1885	21,533,785	98.51	−2,422,653	.87⅞
1886	26,549,827	94.60	+5,016,042	$0.71¼
1887	22,878,241	80.90	−3,671,586	.66¾
1888	16,941,397	61.36	−5,936,844	.87⅝
1889	22,355,225	63.57	+5,413,828	.94⅛
1890	30,073,307	65.63	+7,718,082	.86¾
1891	35,848,777	66.03	+5,775,470	.67
1892	33,432,377	66.19	−2,416,400	.55⅝
1893	31,365,890	64.76	−2,066,487	.64
1894	30,783,424	62.38	− 582,466	.83⅞
1895	30,960,639	58.54	+ 177,215	1.35⅞
1896	33,971,902	55.73	+3,010,263	1.17⅞
1897	35,230,271	58.25	+1,258,369	.78⅝
1898	31,717,425	57.29	−3,512,846	.91⅛
1899	33,068,356	57.94	+1,350,931	1.29⅜
1900	36,295,433	57.05	+3,227,077	1.35¼
1901	33,618,171	48.45	−2,677,262	1.21
1902	32,018,787	36.07	−1,599,384	1.23¾
1903	31,558,248	31.41	− 460,539	1.59
1904	31,408,567	26.83	− 149,681	1.62¾
1905	29,366,960	21.80	−2,041,607	1.39⅜
1906	27,741,472	21.93	−1,625,488	1.59¾
1907	25,342,137	15.26	−2,399,335	1.74½
1908	24,945,517	13.97	− 396,620	1.78
1909	26,535,844	14.49	+1,590,327	1.64⅝
1910	26,892,579	12.83	+ 356,735	1.33⅝
1911	23,749,832	10.77	−3,042,748	1.30 1/12

[a] Price of oil of "Pennsylvania" grade as given by Seep Purchasing Agency.

In the following table is shown the production of the Appalachian field, by States, in the years 1910 and 1911, with the increase and decrease for each State and the percentage of increase or decrease as compared with the previous year:

Production of petroleum in the Appalachian field in 1910 and 1911, by States, showing increase or decrease and percentage of increase or decrease, in barrels.

State.	Production.		Increase.	Decrease.	Percent.	
	1910	1911			Increase.	Decrease.
Pennsylvania	8,794,662	8,248,158	....	546,504	....	6.21
New York	1,053,838	952,515	....	101,323	....	9.61
Southeastern Ohio	4,822,234	4,281,237	....	540,997	....	11.22
West Virginia	11,753,071	9,795,464	....	1,957,607	....	16.66
Kentucky	468,774	472,458	3,684	....	0.0078	....
Total	26,892,579	23,749,832	....	3,142,747	....	11.37

In the following table are given the quantity, value, and price per barrel of the oil produced in the Appalachian field during the years 1910 and 1911, by States:

Quantity and value at wells of petroleum produced in the Appalachian field in 1910 and 1911, by States.

State.	1910			1911		
	Quantity, in barrels.	Value.	Price per barrel.	Quantity, in barrels.	Value.	Price per barrel.
Pennsylvania	8,794,662	$11,908,914	$1.354	8,248,158	$10,894,074	$1.321
New York	1,053,838	1,414,668	1.342	952,515	1,248,950	1.311
Southeastern Ohio	4,822,234	6,469,939	1.342	4,281,237	5,591,423	1.306
West Virginia	11,753,071	15,723,544	1.338	9,795,464	12,767,293	1.303
Kentucky	468,774	324,684	.693	472,458	328,614	.696
Total	26,892,579	35,841,749	1.333	23,749,832	30,830,354	1.298

Production and value of petroleum in the Appalachian field, 1902–1911, by States, in barrels.

Year.	Pennsylvania.		New York.		Southeastern Ohio.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
1902	12,063,880	$15,266,093	1,119,730	$1,530,852	5,136,501	$6,473,287
1903	11,355,156	18,170,881	1,162,978	1,849,135	5,586,433	8,883,182
1904	11,125,762	18,222,242	1,113,264	1,811,837	5,526,571	8,995,386
1905	10,437,195	14,653,278	1,117,582	1,557,630	5,016,736	6,992,885
1906	10,256,893	16,596,943	1,243,517	1,995,377	4,906,579	7,839,359
1907	9,999,306	17,579,706	1,212,300	2,127,748	4,214,391	7,344,408
1908	9,424,325	16,881,194	1,160,128	2,071,533	4,110,121	7,316,617
1909	9,299,403	15,424,554	1,134,897	1,878,217	4,717,436	7,773,880
1910	8,794,662	11,908,914	1,053,838	1,414,668	4,822,234	6,469,939
1911	8,248,158	10,894,074	952,515	1,248,950	4,281,237	5,591,423

Year.	West Virginia.		Kentucky-Tennessee.		Total.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
1902	13,513,345	$17,040,317	185,331	$141,044	32,018,787	$40,451,593
1903	12,899,395	20,516,532	554,286	486,083	31,558,248	49,905,813
1904	12,644,686	20,583,781	998,284	984,938	31,408,567	50,598,184
1905	11,578,110	16,132,631	1,217,337	943,211	29,366,960	40,279,635
1906	10,120,935	16,170,293	1,213,548	1,031,629	27,741,472	43,633,601
1907	9,095,296	15,852,428	820,844	862,396	25,342,137	43,766,686
1908	9,523,176	16,911,865	[a] 727,767	706,811	24,945,517	43,888,020
1909	10,745,092	17,642,283	[a] 639,016	518,299	26,535,844	43,237,233
1910	11,753,071	15,723,544	[a] 468,774	324,684	26,892,579	35,841,749
1911	9,795,464	12,767,293	[a] 472,458	328,614	23,749,832	30,830,354

[a] No production in Tennessee recorded.

In the two following tables is given the production of petroleum in the Appalachian field from 1907 to 1911—in the first by months and in the second by days:

Production of petroleum in the Appalachian oil field, 1907–1911, by months and years, in barrels.

Month.	1907	1908	1909	1910	1911
January	2,064,855	1,968,724	1,989,577	2,274,236	1,974,600
February	1,938,474	1,873,646	1,906,109	2,019,229	1,884,336
March	2,186,092	2,105,483	2,237,778	2,494,868	2,097,333
April	2,169,518	2,072,861	2,158,382	2,296,566	1,974,035
May	2,254,810	2,120,427	2,194,631	2,349,595	2,162,836
June	2,082,385	2,182,340	2,220,971	2,382,097	2,031,071
July	2,245,920	2,172,802	2,306,654	2,239,118	1,914,966
August	2,155,226	2,098,144	2,273,277	2,325,953	2,033,142
September	2,021,582	2,120,175	2,288,067	2,208,040	1,907,771
October	2,138,189	2,103,249	2,309,898	2,148,205	1,964,172
November	1,947,011	1,938,239	2,321,230	2,046,835	1,834,182
December	2,138,075	2,189,427	2,329,270	2,107,837	1,971,408
Total	25,342,137	24,945,517	26,535,844	26,892,579	23,749,832

Average daily production of petroleum in the Appalachian oil field each month, 1907–1911, by months and years, in barrels.

Month.	1907	1908	1909	1910	1911
January	66,608	63,507	64,180	73,362	63,697
February	69,231	64,608	68,075	72,115	67,298
March	70,519	67,919	72,186	80,480	67,656
April	72,317	69,095	71,946	76,552	65,801
May	72,736	68,401	70,795	75,793	69,769
June	69,413	72,745	74,032	79,403	67,702
July	72,449	70,090	74,408	72,230	61,773
August	69,523	67,682	73,332	75,031	65,585
September	67,386	70,673	76,269	73,661	63,592
October	68,974	67,847	74,513	69,297	63,360
November	64,903	64,608	77,374	68,228	61,139
December	68,970	70,627	75,138	67,995	63,594
Average	69,430	68,157	72,701	73,678	65,068

PIPE-LINE STATISTICS FOR THE APPALACHIAN FIELD.

In the following tables are given the pipe-line runs for the principal lines in this field, together with their deliveries for each month in 1911, and the stocks held by these lines at the close of each month for the same period:

Pipe-line runs in the Appalachian oil field in 1911, by lines and months, in barrels.

Month.	National Transit.	Southwest Pennsylvania.	Eureka.	Cumberland.	New York Transit.	Tidewater.
January	293,272	135,624	759,424	32,907	15,620	115,450
February	263,157	127,440	748,799	30,610	13,158	104,799
March	295,877	143,930	826,317	37,586	16,841	118,557
April	291,780	132,473	758,576	35,105	16,021	112,682
May	318,936	151,690	827,867	42,656	16,673	123,662
June	290,795	135,589	783,232	38,259	16,903	116,576
July	266,516	132,451	737,714	41,959	14,056	107,533
August	287,115	136,009	789,774	43,756	16,952	114,079
September	264,283	129,802	726,273	44,014	15,867	109,739
October	279,307	136,796	749,157	41,191	15,969	107,922
November	250,424	121,700	708,769	40,394	14,391	102,516
December	265,499	133,382	772,050	39,876	15,374	110,688
Total	3,366,961	1,616,886	9,187,952	468,313	187,825	1,344,203

Pipe-line runs in the Appalachian oil field in 1911, by lines and months, in barrels—Con.

Month.	Producers and Refiners.	Emery.	Buckeye Macksburg.	Franklin.	Other lines.	Total.
January	178,392	28,606	280,007	3,896	131,402	1,974,600
February	169,926	26,358	276,226	2,650	121,213	1,884,336
March	184,475	29,059	300,978	4,022	139,691	2,097,333
April	176,473	28,071	276,723	3,938	142,193	1,974,035
May	188,386	29,114	307,447	3,960	152,445	2,162,836
June	177,665	29,066	299,298	4,337	139,351	2,031,071
July	172,355	27,295	272,176	3,286	139,605	1,914,946
August	177,858	29,231	291,845	3,669	142,854	2,033,142
September	169,461	26,626	282,903	2,720	136,083	1,907,771
October	169,156	28,598	291,796	4,683	139,597	1,964,172
November	157,840	25,524	281,350	3,576	127,698	1,834,182
December	166,544	28,385	297,274	3,875	138,461	1,971,408
Total	2,088,531	335,933	3,458,023	44,612	1,650,593	23,749,832

Pipe-line deliveries in the Appalachian oil field in 1911, by lines and months, in barrels.

Month.	National Transit.	Southwest Pennsylvania.	Eureka.	Cumberland.	Southern.	Crescent.	New York Transit.
January	1,663,081	153,167	79,063	217	501,091	125.956	1,272,054
February	1,446,378	165,031	70,716	9	482,458	159.068	1,157,480
March	1,491,851	185,944	80.388	1,991	643,342	148,612	1,314,882
April	1,664,399	165,538	59,642	800	599,707	176.601	1,369,734
May	1,669,583	161,199	78,282	8,853	621,025	82,891	1,372,212
June	1,608,881	149,088	44,324	9,021	529,644	146,138	1,215,487
July	1,741,995	155,732	45,223	29,283	687,200	174.405	1,544,432
August	1,869,844	202,918	52,638	14,132	613,132	157.606	1,250,891
September	1,779,454	176,161	82,765	12,905	649,113	162.185	1,218,875
October	1,936,852	191,350	79,731	11,161	606,754	192,150	1,399,949
November	1,699,369	163,709	75,948	10,640	522,550	137.233	1,221,898
December	1,695,793	166,103	86,880	10,079	587,507	171.456	1,320,881
Total	20,267,480	2,035,940	835,600	109,091	7,043,523	1,834,301	15,658,775

Month.	Tidewater.	Producers and Refiners.	Emery.	Buckeye Macksburg.	Franklin.	Other lines.[a]	Total.
January	183,809	172,756	29,297	2,874	7,368	137,623	4,328,356
February	151,760	146,319	27,622	2,355	3,792	137,623	3,950,611
March	139,199	194,389	27,029	2,223	2,285	137,623	4,369,758
April	182,304	247,281	27,955	2,489	....	137,623	4,634,073
May	173,761	207,987	28,131	2,079	....	137,623	4,543,626
June	156,993	176,196	29,182	4,316	....	137,623	4,206,893
July	180,671	177,768	27,910	2,561	....	137,623	4,904,803
August	125,083	199,254	30,475	1,624	....	137,623	4,655,220
September	132,878	158,513	26,436	5,248	1,435	137,623	4,543,591
October	189,485	120,934	27,955	3,376	5,556	137,623	4,902,876
November	163,165	122,741	25,770	2,536	6,825	137.623	4,290,007
December	157,091	194,571	28,544	4,631	10.822	137.623	4,571,981
Total	1,936,199	2,118,709	336,306	36.312	38,083	1,651,476	53,901,795

[a] Averaged.

Gross stocks held by pipe lines in the Appalachian oil field at close of each month, in 1911, in barrels.

Month.	National Transit.	Southwest Pennsylvania.	Eureka.	Cumberland.	Southern.	Crescent.	New York Transit.	Tidewater.
January	1,796,707	955,021	1,330,868	264,083	912,742	115,296	2,198,402	321,904
February	1,808,129	978,096	1,362,284	260,729	911,197	94,367	2,264,807	330,026
March	1,861,429	994,734	1,322,233	262,884	827,240	100,212	2,378,884	364,891
April	1,801,047	897,957	1,364,876	263,186	756,500	64,661	2,278,645	380,219
May	1,924,098	888,864	1,344,751	265,423	830,412	139,129	2,155,759	358,108
June	2,039,806	1,145,507	1,354,836	260,274	832,698	145,843	2,268,412	344,405
July	1,940,591	996,746	1,372,592	240,023	818,936	129,450	2,325,781	326,279
August	1,685,383	1,099,186	1,193,752	238,976	945,081	135,451	2,715,856	340,959
September	1,625,152	941,511	1,212,833	230,730	834,185	129,496	2,704,018	398,796
October	1,247,721	767,765	1,226,900	210,165	776,282	93,229	2,785,151	345,743
November	1,052,365	823,471	1,303,725	188,335	753,356	103,261	2,803,593	310,871
December	1,161,046	996,483	1,302,420	178,544	637,853	84,612	2,488,641	291,069

Month.	Northern.	Producers and Refiners.	Emery.	United States.	Buckeye Macksburg.	Franklin	Other pipe lines.	Total.
January	797,630	233,604	12,450	55,701	285,244	50,394	....	....
February	843,996	257,211	11,185	44,348	304,524	49,649	....	....
March	1,009,443	247,296	13,216	45,711	311,919	51,782	....	....
April	1,085,918	176,488	13,332	71,519	310,407	55,165	....	....
May	1,443,950	156,907	14,134	58,290	311,836	55,570	....	....
June	1,288,567	158,377	14,199	49,851	301,157	62,351	....	....
July	1,319,059	152,964	13,583	63,102	297,169	65,082	....	....
August	1,274,024	131,586	12,239	52,530	293,487	68,196	....	....
September	1,475,937	142,533	12,530	48,440	288,516	69,877	....	....
October	1,519,760	190,756	13,173	44,420	268,636	70,368	....	....
November	1,639,306	225,854	12,926	48,744	274,405	66,549	....	....
December	1,672,216	197,827	12,767	58,137	282,090	59,998	70,659	9,494,362

PRICES OF APPALACHIAN OIL.

The following table shows the range of prices paid by the Seep Purchasing Agency for the different grades of Appalachian oil in 1910 and 1911:

Range of prices paid at wells by the Seep Purchasing Agency for light petroleum produced in the New York, Ohio, Pennsylvania, and West Virginia oil regions during 1910 and 1911, per barrel of 42 gallons.

Date.	Pennsylvania and Tiona, Pa.	Mercer black, Pennsylvania.	Corning, Ohio.	New Castle, Ohio.	Cabell, W. Va.
1910.					
Jan. 1	$1.43	$0.90	$0.79	$0.87	$0.97
Jan. 7	1.40	.90	.79	.87	.97
Apr. 8.	1.35	.90	.79	.87	.97
June 11	1.30	.87	.77	.84	.94
1911.					
Jan. 1	1.30	.87	.77	.84	.94
Dec. 26	1.35	.92	.82	.89	.99

In the following table is given the average price per month of the different light oils of New York, Pennsylvania, Ohio, and West Virginia during the years 1910 and 1911.

Average monthly prices of Appalachian petroleum in 1910 and 1911, per barrel.

Month.	Pennsylvania and Tiona, Pa.	Mercer black, Pennsylvania.	Corning, Ohio.	New Castle, Ohio.	Cabell, W. Va.
1910.					
January	$1.40½	$0.90	$0.79	$0.87	$0.97
February	1.40	.90	.79	.87	.97
March	1.40	.90	.79	.87	.97
April	1.36⅛	.90	.79	.87	.97
May	1.35	.90	.79	.87	.97
June	1.31¾	.88	.77¾	.85	.95
July	1.30	.87	.77	.84	.94
August	1.30	.87	.77	.84	.94
September	1.30	.87	.77	.84	.94
October	1.30	.87	.77	.84	.94
November	1.30	.87	.77	.84	.94
December	1.30	.87	.77	.84	.94
Average	1.33⅝	.88¼	.77⅞	.85¼	.95¼
1911.					
January	1.30	.87	.77	.84	.94
February	1.30	.87	.77	.84	.94
March	1.30	.87	.77	.84	.94
April	1.30	.87	.77	.84	.94
May	1.30	.87	.77	.84	.94
June	1.30	.87	.77	.84	.94
July	1.30	.87	.77	.84	.94
August	1.30	.87	.77	.84	.94
September	1.30	.87	.77	.84	.94
October	1.30	.87	.77	.84	.94
November	1.30	.87	.77	.84	.94
December	1.31	.88	.78	.85	.95
Average	1.308	.871	.771	.841	.941

The average monthly and yearly prices per barrel of Pennsylvania petroleum at wells in the years 1902–1911 are given in the following table:

Monthly and yearly average prices of pipe-line certificates of Pennsylvania petroleum at wells in daily market, 1902–1911, per barrel.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Yearly average.
1902	$1.15	$1.15	$1.15	$1.17½	$1.20	$1.20⅜	$1.22	$1.22	$1.22	$1.28⅛	$1.38¼	$1.49	$1.23¾
1903	1.52½	1.50	1.50	1.51	1.51½	1.50	1.52½	1.56	1.57¼	1.68½	1.78¾	1.88⅜	1.59
1904	1.85	1.82	1.72⅛	1.65½	1.62	1.58⅝	1.52	1.50	1.53¾	1.56	1.58¾	1.57	1.62¾
1905	1.43⅛	1.39	1.38¼	1.32¾	1.28¾	1.27	1.27	1.27	1.35⅜	1.57½	1.59	1.58	1.39⅜
1906	1.58	1.58	1.58	1.60⅜	1.64	1.64	1.63⅝	1.58	1.58	1.58	1.58	1.58	1.59¾
1907	1.58	1.61¼	1.72⅞	1.78	1.78	1.78	1.78	1.78	1.78	1.78	1.78	1.78	1.74½
1908	1.78	1.78	1.78	1.78	1.78	1.78	1.78	1.78	1.78	1.78	1.78	1.78	1.78
1909	1.78	1.78	1.78	1.78	1.70	1.67¼	1.60¼	1.58	1.58	1.56¼	1.49	1.44⅜	1.64⅝
1910	1.40½	1.40	1.40	1.36⅛	1.35	1.31¾	1.30	1.30	1.30	1.30	1.30	1.30	1.33⅝
1911	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.31	1.308

The following table shows the range of prices of Pennsylvania crude oil each year since 1859:

Highest and lowest prices of Pennsylvania crude petroleum each year, 1859–1911, per barrel.

Year.	Highest.		Lowest.	
	Month.	Price.	Month.	Price.
1859	September	$20.00	December	$20.00
1860	January	20.00	.....do	2.00
1861	.....do	1.75	.....do	.10
1862	December	2.50	January	.10
1863	.....do	4.00	.....do	2.00
1864	July	14.00	February	3.75
1865	January	10.00	August	4.00
1866	.....do	5.50	December	1.35
1867	October	4.00	June	1.50
1868	July	5.75	January	1.70
1869	January	7.00	December	4.25
1870	.....do	4.90	August	2.75
1871	June	5.25	January	3.25
1872	October	4.55	December	2.67½
1873	January	2.75	November	.82½
1874	February	2.25	.....do	.62½
1875	.....do	1.82½	January	.75
1876	December	4.23¾	.....do	1.47½
1877	January	3.69⅜	June	1.53¾
1878	February	1.87½	September	.78¾
1879	December	1.28¾	June	.63⅛
1880	June	1.24⅜	April	.71¼
1881	September	1.01¼	July	.72½
1882	November	1.37	.....do	.49¼
1883	June	1.24¾	January	.83¼
1884	January	1.15⅝	June	.51¼
1885	October	1.12⅝	January	.68
1886	January	.92¼	August	.59¾
1887	December	.90	July	.54
1888	March	1.00	June	.71⅜
1889	November	1.12½	April	.79½
1890	January	1.07⅝	December	.60¾
1891	February	.81⅜	August	.50
1892	January	.64⅛	October	.50
1893	December	.80	January	.52⅞
1894	.....do	.95¾	.....do	.78½
1895	April	2.60	.....do	.95¼
1896	January	1.50	December	.90
1897	March	.96	October	.65
1898	December	1.19	January	.65
1899	.....do	1.66	February	1.13
1900	January	1.68	November	1.05
1901	January, September	1.45	May	.80
1902	December	1.54	January, February, March	1.15
1903	.....do	1.90	January, February, March, April, May, June, July.	1.50
1904	January	1.85	July, December	1.50
1905	October	1.61	May	1.27
1906	April, May, June, July	1.64	January, February, March, April, August, September, October, November, December.	1.58
1907	March to December, inclusive	1.78	January	1.58
1908	No change	1.78	No change	1.78
1909	January, February, March	1.78	December	1.43
1910	January	1.43	June to December, inclusive	1.30
1911	December	1.35	January to December	1.30

PENNSYLVANIA.

Just after the beginning of 1911 a well of gusher proportions was drilled on the Katherine Hagan farm in Springhill Township, Greene County. The well produced 900 barrels the first day, but rapidly declined. It aroused little interest.

The Bristoria pool in this county, which aroused interest in 1910, yielded a good producer late in the year. It started at 300 barrels and stimulated much further drilling.

In April a well was drilled on the Schwartz Bros.' farm near Perrysville, Allegheny County. It proved so good and lasting a producer as to induce much leasing and drilling, but light wells and dry holes resulted, and in three months interest had declined.

About the middle of the year a well was drilled in Canonsburg, Washington County, starting at 60 barrels a day. This and a second good producer started a "town-lot" excitement, with 15 wells drilling.

This year saw the abandonment of the Gantz well, drilled in 1885 in Washington County—the oldest in that field. It was the first drilled to the Gantz sand. In its first year it was deepened to the Gordan sand and yielded 55 barrels a day. This gradually declined to one-fourth barrel a day in 1911.

The new developments recorded above were useful in stimulating drilling, but this did not prevent a loss of 6.21 per cent in the product of the State in 1911 compared with the preceding year. The results are tabulated below.

NEW YORK.

The oil pools in New York constitute the northern end of the Appalachian oil field. Oil has been produced in Cattaraugus, Allegany, and Steuben counties since the early days of the oil industry in Pennsylvania, when prospecting rapidly extended north to New York State. The oil-bearing formations found in Pennsylvania are much nearer the surface in New York, but in spite of the shallower character of the wells they have proved wonderfully persistent. In fact the Triangle well on the edge of Scio Township in Allegany County is still being pumped, although it was the first commercial well drilled in New York in 1879. It yields an average of about one-eighth of a barrel a day, being pumped twice a week. The world's record is probably being made here in New York State for the successful working of old oil wells whose production has declined to extremely small fractions of a barrel per day. Cases were noted where a month's yield of groups of 20 or more wells showed less than 0.025 barrel per well per day. Although such wells are, of course, barely worth pumping, the fact that they can be kept producing without actual loss and that they give employment to many gaugers, pumpers, and mechanics, is most satisfactory evidence of the thrift and mechanical ingenuity of the oil fraternity in this region. Advantage is taken by them of every modern device for cheapening the transmission of power from the central station to the group of wells pumped by it, especially transmission by compressed air to air pumps installed on top of the well casing.

PRODUCTION.

The following table shows the production of petroleum in Pennsylvania and New York, 1907–1911, by months:

Production of petroleum in Pennsylvania and New York in 1907–1911, by months, in barrels.

PENNSYLVANIA.

Month.	1907	1908	1909	1910	1911
January	824,081	782,683	759,178	721,627	697,254
February	742,149	718,905	704,391	621,467	637,683
March	874,478	835,990	822,600	851,225	722,719
April	847,748	803,590	784,155	766,700	701,453
May	875,529	805,930	818,359	759,585	765,434
June	826,192	819,020	820,155	790,520	704,047
July	900,025	806,003	792,327	723,646	668,289
August	842,609	781,988	786,563	763,273	704,591
September	799,053	786,963	774,750	720,165	661,739
October	852,446	781,001	758,779	708,453	690,324
November	779,009	710,246	765,504	678,132	622,507
December	835,987	792,006	712,642	689,869	671,688
Total	9,999,306	9,424,325	9,299,403	8,794,662	8,247,728

NEW YORK.

Month.	1907	1908	1909	1910	1911
January	100,887	98,776	95,270	90,027	83,160
February	89,502	87,119	89,526	71,699	73,007
March	105,662	99,948	100,008	101,406	83,226
April	102,975	100,511	96,249	92,245	81,239
May	107,406	97,365	98,490	90,581	88,594
June	98,809	99,954	99,905	92,064	84,442
July	106,231	99,338	96,247	89,457	75,885
August	102,093	95,754	93,900	89,650	81,368
September	98,236	96,299	93,583	86,428	76,263
October	103,308	98,556	90,382	86,659	78,469
November	96,772	89,345	91,058	79,519	70,101
December	100,419	97,163	90,279	84,103	76,761
Total	1,212,300	1,160,128	1,134,897	1,053,838	952,515

WELL RECORD.

The following tables give the well records for Pennsylvania and New York from 1907 to 1911, inclusive:

Number of wells completed in the Pennsylvania and New York oil fields, 1907–1911, by districts.

District.	Completed.					Dry.					Oil.				
	1907	1908	1909	1910	1911	1907	1908	1909	1910	1911	1907	1908	1909	1910	1911
Bradford	305	359	571	344	298	37	44	36	6	16	268	315	535	316	260
Allegany	581	473	459	283	194	89	66	40	13	9	492	407	419	219	128
Middle	563	620	506	235	247	136	89	65	34	39	427	531	441	195	208
Venango and Clarion	1,997	1,841	1,881	790	805	217	201	199	70	93	1,780	1,640	1,682	635	642
Butler and Armstrong	435	520	487	263	219	164	204	178	89	65	271	316	309	152	124
Southwest Pennsylvania	451	347	319	286	244	205	153	145	76	75	246	194	174	156	129
Total	4,332	4,160	4,223	2,201	2,007	[a] 848	[a] 757	[a] 663	[b] 288	[b] 297	3,484	3,403	3,560	1,673	1,491

[a] Including gas wells.

[b] Not including gas wells.

Number of wells completed in the Pennsylvania and New York oil fields, 1907–1911, by months.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1907	272	201	218	293	405	431	436	432	447	453	429	315	4,332
1908	241	146	207	324	337	428	417	414	455	434	405	352	4,160
1909	325	298	260	370	436	418	413	384	400	274	368	247	4,223
1910	147	132	109	190	266	250	222	211	179	182	188	125	2,201
1911	100	96	87	130	168	198	191	222	205	210	227	173	2,007

Number of dry holes drilled in the Pennsylvania and New York oil fields, 1907–1911, by months.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1907	58	43	51	62	67	85	87	90	88	75	74	68	[a] 848
1908	65	27	56	59	48	76	61	72	76	61	86	70	[a] 757
1909	57	43	33	53	62	57	54	76	62	59	52	55	[a] 663
1910	33	38	27	45	53	58	52	53	39	46	42	42	[a] 528
1911	22	25	23	33	33	28	19	32	22	22	25	13	[b] 297

[a] Including gas wells.

[b] Not including gas wells.

Total and average initial daily production of new wells in the Pennsylvania and New York oil fields, 1907–1911, by districts, in barrels.

District.	Total initial production.					Average initial production per well.				
	1907	1908	1909	1910	1911	1907	1908	1909	1910	1911
Bradford	632	874	1,345	952	730	2.36	2.77	2.51	3.01	2.81
Allegany	1,147	806	815	368	201	2.33	1.98	1.94	1.68	1.57
Middle	1,378	1,257	977	442	541	3.23	2.37	2.22	2.27	2.60
Venango and Clarion	5,779	4,052	4,573	1,276	1,302	3.25	2.47	2.72	2.00	2.03
Butler and Armstrong	1,579	1,532	2,493	1,489	422	5.83	4.85	8.07	9.80	3.40
Southwest Pennsylvania	2,636	1,383	1,130	2,156	1,716	10.71	7.13	6.49	13.82	13.30
Total	13,151	9,904	11,333	6,683	4,912	3.77	2.91	3.18	3.99	3.29

Total initial daily production of new wells in the Pennsylvania and New York oil fields, 1907–1911, by months, in barrels.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1907	1,024	802	753	1,134	1,060	1,176	1,822	961	1,156	1,187	1,256	820	13,151
1908	523	396	476	746	816	960	1,119	1,114	1,013	1,029	964	748	9,904
1909	869	785	608	930	1,084	1,027	1,011	1,148	1,046	1,082	991	752	11,333
1910	572	320	211	584	1,355	621	604	924	353	395	448	296	6,683
1911	204	345	154	313	319	368	435	611	517	507	695	444	4,912

WEST VIRGINIA.

PRODUCTION.

The Elk Hills of Kanawha County was the chief region of interest in oil exploration in West Virginia in 1911. Wildcatting was very active throughout the oil districts, Wetzel, Marion, Ritchie, and Roane counties leading, but a general decline was evident in all but Roane County, where the wells in the Big Injun sand are long lived and the district is chiefly in the hands of the larger companies who operate conservatively.

Blue Creek Pool.—For years the effort has been almost continuous to bring Kanawha County into the producing list, but it was not till early fall of 1911 that the first promising discovery was made. To the Ohio Fuel Oil Co. belongs the credit for the discovery when it drilled its well on the Barth-Schwartz farm, located on Blue Creek, Elk district, into the Squaw sand and got a producer that had an initial production of more than 100 barrels a day. As a producing formation, the Squaw sand has not been in favor and the well was regarded for a time as a freak. This seemed to be confirmed by a light producer completed to the northwest and another of the same kind to the southwest. A few weeks later the Ohio Fuel Oil Co. drilled in a test on the Grace E. Myers farm, located half a mile south of the Barth-Schwartz producer, and the result was a better well than the first. At the close of the year the Barth-Schwartz well was holding up at more than 75 barrels and the Myers farm well at 115 barrels. As yet the pool has neither length nor breadth. The wells now drilling when completed will furnish the desired information as to the direction to look for an extension. One thing is certain, no other section in the eastern fields will receive so much attention during the year 1912 as Kanawha County, with the prospect of a total increase for the State. The year 1911 showed a marked decline in the State production of 16.66 per cent as shown in the tables which follow.

In the following table is given the production of petroleum in West Virginia in the years 1907 to 1911, by months:

Total production of petroleum in West Virginia, 1907–1911, by months, in barrels.

Month.	1907	1908	1909	1910	1911
January	687,251	697,040	735,379	1,026,438	814,743
February	695,616	700,103	722,045	935,252	800,712
March	771,814	770,689	851,002	1,050,163	881,172
April	770,274	779,089	833,432	962,657	810,661
May	821,554	823,144	829,833	1,001,746	882,093
June	747,071	870,289	870,909	1,018,694	832,920
July	812,437	864,877	904,745	984,813	787,171
August	785,620	815,242	923,438	1,020,317	838,922
September	374,077	803,139	950,188	976,220	773,024
October	765,671	795,539	997,295	935,166	795,687
November	696,694	739,605	1,016,738	906,521	757,029
December	807,217	864,420	1,110,088	935,084	821,330
Total	9,095,296	9,523,176	10,745,092	11,753,071	9,795,464

The quantity and value of petroleum produced in West Virginia from 1902 to 1911, inclusive, are shown in the following table:

Quantity and value of petroleum produced in West Virginia, 1902–1911.

Year.	Regular crude.			Lubricating crude.			Total.		
	Quantity.	Value.	Price per barrel.	Quantity.	Value.	Price per barrel.	Quantity.	Value.	Price per barrel.
	Barrels.			*Barrels.*			*Barrels.*		
1902	13,498,685	$17,006,469	$1.26	14,660	$33,848	$2.31	13,513,345	$17,040,317	$1.261
1903	12,893,079	20,499,996	1.59	6,316	16,536	2.62	12,899,395	20,516,532	1.59
1904	12,636,253	20,557,556	1.627	8,433	26,225	3.11	12,644,686	20,583,781	1.628
1905	11,573,545	16,117,816	1.393	4,565	14,815	3.25	11,578,110	16,132,631	1.393
1906	10,111,647	16,138,811	1.596	9,288	31,482	3.39	10,120,935	16,170,293	1.598
1907	9,089,839	15,834,714	1.74	5,457	17,714	3.25	9,095,296	15,852,428	1.743
1908	9,519,875	16,902,968	1.775	3,301	8,897	2.70	9,523,176	16,911,865	1.776
1909	10,742,026	17,634,335	1.642	3,066	7,948	2.59	10,745,092	17,642,283	1.642
1910	11,751,018	15,717,796	1.338	2,053	5,748	2.80	11,753,071	15,723,544	1.338
1911	9,792,324	12,757,861	1.302	3,140	9,432	3.00	9,795,464	12,767,293	1.303

WELL RECORD.

The following tables give the well records for West Virginia from 1907 to 1911, inclusive:

Number of wells completed in West Virginia, 1907–1911, by months.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1907	84	90	98	124	135	112	104	142	112	99	104	110	1,314
1908	89	101	85	98	115	113	119	136	134	117	124	116	1,347
1909	130	144	143	140	131	155	151	168	182	171	178	164	1,857
1910	146	123	122	146	153	157	148	129	137	132	108	115	1,616
1911	102	108	106	100	96	81	105	107	101	98	80	107	1,191

Number of wells completed in West Virginia in 1911, by districts and months.[a]

District.	Jan.	Feb	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.	Total 1910.
Brooke County	1	.....	.....	.....	.....	.....	2	.....	.....	.....	.....	.....	3	26
Burning Springs	1	1	.....	2	1	1	4	6	2	4	4	5	31	30
Cabell County	1	.....	1	2	.....	1	.....	.....	.....	.....	.....	.....	5	17
Calhoun County	1	.....	7	2	2	2	1	4	3	4	5	2	33	24
Hancock County	.....	.....	.....	.....	.....	1	.....	1	1	2	3	.....	8	7
Lincoln County	7	1	7	3	2	5	5	10	7	10	1	10	68	148
Mannington	35	32	24	31	15	14	31	17	22	21	18	20	280	500
Pleasants County	4	4	11	5	8	9	6	6	11	7	6	13	90	141
Ritchie County	11	13	13	12	15	13	16	20	11	14	16	16	170	159
Roane County	23	24	19	13	19	13	21	16	13	17	6	10	194	269
Sistersville	1	3	1	1	5	1	3	1	.....	1	.....	1	18	10
Wetzel and Tyler Counties	10	15	8	11	9	8	.....	15	17	9	6	9	117	162
Wood County	4	6	9	4	6	6	3	7	7	6	11	11	80	75
Miscellaneous	3	9	6	14	14	7	13	4	7	3	4	10	94	48
Total	102	108	106	100	96	81	105	107	101	98	80	107	1,191	1,616

[a] Including gas wells.

Number of oil wells and dry holes drilled in West Virginia in 1911, by districts and months.

District.	Jan.		Feb.		Mar.		Apr.		May.		June.		July.		Aug.		Sept.		Oct.		Nov.		Dec.		Total.	
	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.
Brooke County	..	1	..	...	..	...	..	...	..	...	...	...	1	1	..	...	...	...	..	..	..	...	..	...	1	2
Burning Springs	1	...	1	...	..	..	1	1	..	1	1	...	3	...	4	1	1	1	3	...	4	...	3	1	22	5
Cabell County	..	1	..	...	..	1	1	...	..	...	...	...	...	...	..	...	...	...	..	...	..	...	...	...	1	2
Calhoun County	..	...	..	...	..	...	1	...	..	1	2	...	...	...	3	...	1	1	1	...	3	...	...	...	11	2
Hancock County	..	...	..	...	..	...	..	...	..	...	1	...	...	...	1	...	1	...	2	...	3	...	...	...	8	...
Lincoln County	5	1	1	...	6	...	3	...	2	...	4	...	4	...	7	2	6	...	9	...	1	...	10	...	58	3
Mannington	14	4	9	5	9	4	9	3	7	...	4	2	11	6	5	1	7	5	10	3	4	4	9	2	98	39
Pleasants County	4	...	2	2	7	4	3	2	6	2	6	3	4	2	1	5	8	3	6	1	2	3	11	2	60	29
Ritchie County	6	4	10	2	6	4	8	2	10	2	6	5	11	4	8	10	8	...	4	7	10	1	6	4	93	45
Roane County	15	2	15	2	15	1	12	...	17	1	12	...	18	...	15	..	13	...	13	2	5	...	10	...	160	8
Sistersville	..	1	1	2	1	...	1	...	3	1	...	1	2	1	..	1	...	...	..	1	..	...	...	1	8	9
Wetzel and Tyler Counties	4	4	5	4	3	1	2	4	5	...	3	...	...	...	2	4	1	2	4	2	4	1	2	3	35	25
Wood County	4	...	2	4	4	5	3	1	4	2	5	1	2	1	4	3	4	3	5	1	8	3	4	7	49	31
Miscellaneous	..	1	1	3	1	1	1	1	2	...	...	...	4	5	1	1	...	4	1	...	2	...	5	2	18	18
Total	53	19	47	24	52	21	45	11	56	10	44	12	60	20	51	28	56	19	58	17	46	12	60	22	622	218

Initial daily production of new wells completed in West Virginia in 1911, by districts and months, in barrels.

District.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.	Total 1910.
Brooke County	.....	.....	.....	.....	.....	.....	3	.....	.....	.....	.....	.....	3	59
Burning Springs	25	5	.....	3	.....	2	57	6	2	4	31	9	144	69
Cabell County	.....	.....	.....	5	.....	.....	.....	.....	.....	.....	.....	.....	5	28
Calhoun County	.....	.....	.....	30	.....	5	.....	105	25	50	80	.....	295	196
Hancock County	.....	.....	.....	.....	.....	2	.....	5	5	3	14	.....	29	7
Lincoln County	48	15	178	63	35	85	60	145	120	180	15	143	1,087	2,397
Mannington	146	205	91	209	171	181	360	65	118	142	425	67	2,180	12,426
Pleasants County	14	13	24	25	38	21	23	15	101	22	25	53	374	1,050
Ritchie County	173	171	100	156	268	180	165	132	100	62	62	92	1,661	3,621
Roane County	248	415	313	340	355	240	286	292	193	258	65	238	3,243	3,966
Sistersville	.....	5	5	5	35	.....	6	.....	.....	.....	.....	.....	56	141
Wetzel and Tyler Counties	145	72	14	20	23	15	.....	6	25	105	160	20	605	1,752
Wood County	14	27	38	11	31	36	4	58	11	24	56	27	337	402
Miscellaneous	.....	10	10	2	35	.....	51	5	.....	15	75	221	424	80
Total	813	938	773	869	991	767	1,015	834	700	865	1,008	870	10,443	26,194

Total initial daily production of new wells in West Virginia, 1907–1911, by months, in barrels.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.	Average.
1907	688	1,369	2,042	2,024	2,136	1,488	3,401	1,992	1,798	811	1,027	1,563	20,339	1,695
1908	2,185	2,298	1,423	2,033	3,310	3,853	2,682	2,473	2,498	1,912	1,661	1,997	28,325	2,360
1909	1,682	1,781	2,221	2,337	1,795	2,656	3,014	3,812	3,615	7,362	4,048	9,141	43,464	3,622
1910	4,523	3,559	2,092	2,094	2,085	2,533	1,647	1,500	2,608	1,542	1,408	603	26,194	2,183
1911	813	938	773	869	991	767	1,015	834	700	865	1,008	870	10,443	870

KENTUCKY.

The many occurrences of oil in Kentucky can be grouped for convenient reference into three fields. Of these the Lawrence County field is an extension of the Wayne County field of West Virginia; the Wayne County (Ky.) field is on the southern boundary of the State and represents the center of production in recent years; and the Ohio County region, although hardly definable as a field, is a locality of interest on account of the recent attempts to extend the Illinois and Indiana field south into Kentucky. The Lawrence County field also includes development work in adjoining counties. The oil is like the adjoining West Virginia crude, and is found in the Berea sand.

Drilling began in Lawrence County in 1910 and in spite of many disappointments has been carried on vigorously but with indifferent success. The Wayne County oil, though classed as Appalachian oil, usually shows a heavier gravity. The strikes of oil in this region in the last few years have been just about sufficient to justify continued drilling. The Mount Pisgah and Griffin pools were the best developed in this county, the latter promising to be one of the greatest yet found in Kentucky. In these pools many new wells were drilled which though small were profitable and sufficient to increase the product from 468,774 barrels in 1910 to 472,458 barrels in 1911. The previous four years have shown a decline.

The wildcatting in western Kentucky was fairly active in Muhlenberg, Ohio, and adjoining counties, and at the close of the year was stimulated by the development of a small well in Ohio County.

PRODUCTION.

In the following table is given the production of petroleum in Kentucky and Tennessee, by months, from 1907 to 1911, inclusive:

Production of petroleum in Kentucky and Tennessee, by months, 1907–1911, in barrels.

Month.	1907	1908	1909	1910	1911
January	77,034	60,781	59,799	40,984	33,237
February	67,939	60,168	56,355	35,795	31,151
March	78,438	59,336	63,085	41,006	37,910
April	73,467	63,283	55,681	39,907	35,484
May	72,728	65,927	57,065	43,055	42,906
June	64,120	60,127	53,522	44,239	38,509
July	66,940	60,150	55,414	40,009	42,237
August	66,131	60,533	54,777	40,699	44,087
September	66,493	60,137	54,221	41,017	44,356
October	65,142	55,385	46,330	35,822	41,556
November	60,860	59,643	41,772	29,144	40,818
December	61,552	62,297	40,995	37,097	40,207
Total	820,844	[a] 727,767	[a] 639,016	[a] 468,774	[a] 472,458

[a] No production in Tennessee recorded.

Pipe-line runs in Kentucky in 1911, by districts and months, in barrels.

Month ending—	Cooper.	Griffin.	Johnson Fork.	Mount Pisgah.	Parmleysville.	Slickford.	Steubenville.	Total, Wayne County.	Beaver Creek.	Campton.	Ragland.	Watson.	Williamsburg.	Total.
Jan. 28	3,615	......	1,228	5,444	7,928	2,146	3,273	23,634	906	5,111	1,247	....	216	31,114
Feb. 25	3,665	......	885	6,281	8,185	1,801	3,139	23,956	625	4,137	......	....	216	28,934
Mar. 25	3,620	......	985	6,596	7,818	2,061	3,034	24,114	945	4,228	......	....	216	29,503
Apr. 29	5,975	......	260	12,006	10,778	2,701	4,401	36,121	690	4,727	1,664	....	322	43,524
May 27	4,123	......	......	8,796	8.101	2,166	2,521	25,707	507	4,068	5,686	....	216	36,184
June 24	4,653	......	......	8,590	8,751	2,018	3,083	27,095	875	3,853	6,605	....	216	38,644
July 28	5,225	......	......	10,832	9,324	1,639	3,049	30,069	808	1,605	4,466	....	216	37,164
Aug. 26	4,967	......	......	12,352	13,349	2,495	3.587	36,750	942	6,873	4.636	....	322	49,523
Sept. 23	3,813	......	......	9,041	14,083	1,683	2,860	31,480	697	4,130	3,608	....	216	40,131
Oct. 28	5,102	......	......	10,242	14,727	2,245	3,094	35,410	1,371	4,631	4,182	....	323	45,917
Nov. 25	3,671	......	......	8,346	11,220	2,033	2,272	27,542	1,039	2,952	5,151	....	108	36,792
Dec. 30	5,701	4,022	......	9,146	11,834	1,541	2,936	35,180	1,097	4,817	4,988	68	215	46,365
Total	54,130	4,022	3,358	107,672	126,098	24,529	37,249	357,058	10,502	51,132	42,233	68	2,802	463,795

In the following table are given the dates of change and the changes in prices of the different grades of petroleum produced in Kentucky during the years 1910 and 1911:

Fluctuations in prices, per barrel, of Kentucky petroleum in 1910 and 1911.

1910			1911		
Date.	Somerset (light).	Ragland (heavy).	Date.	Somerset (light).	Ragland (heavy).
Jan. 1	$0.72	$0.50	Jan. 1	$0.72	$0.45
Jan. 8	.72	.45	Sept. 16	.74	.45
			Dec. 26	.79	.48

In the following table are given the average monthly prices of Kentucky petroleum, per barrel of 42 gallons, in the years 1907 to 1911, inclusive:

Average monthly prices, per barrel, at wells, of Kentucky petroleum in 1907–1911.

Month.	Somerset (light).					Ragland (heavy).				
	1907	1908	1909	1910	1911	1907	1908	1909	1910	1911
January	$0.85	$1.00	$1.00	$0.72	$0.72	$0.59⅜	$0.75	$0.65	$0.46⅛	$0.45
February	.86¼	1.00	1.00	.72	.72	.60	.75	.65	.45	.45
March	.95½	1.00	.97¾	.72	.72	.61½	.75	.63⅞	.45	.45
April	1.20	1.00	.90	.72	.72	.63⅞	.75	.60	.45	.45
May	1.20	1.00	.81⅞	.72	.72	.70	.75	.60	.45	.45
June	1.20	1.00	.79¼	.72	.72	.75	.72¾	.59¼	.45	.45
July	1.20	1.00	.73½	.72	.72	.75	.65⅜	.52⅜	.45	.45
August	1.20	1.00	.72	.72	.72	.75	.65	.50	.45	.45
September	1.20	1.00	.72	.72	.73	.75	.65	.50	.45	.45
October	1.18⅞	1.00	.72	.72	.74	.75	.65	.50	.45	.45
November	1.03½	1.00	.72	.72	.74	.75	.65	.50	.45	.45
December	1.00	1.00	.72	.72	.75	.75	.65	.50	.45	.46
Average	1.09⅛	1.00	.81⅞	.72	.727	.70	.69⅞	.56¼	.45⅛	.456

WELL RECORD.

In the following tables are given the well records for Kentucky and Tennessee from 1907 to 1911, inclusive:

Number of wells completed in Kentucky and Tennessee, 1907–1911, by counties.

County.	Completed.					Dry.					Oil.				
	1907	1908	1909	1910	1911	1907	1908	1909	1910	1911	1907	1908	1909	1910	1911
Bath	4	3	1	....	....	4	....	1	....	....	....	3	....	....	....
Carter	....	....	....	1	....	....	....	....	1	....	....	....	....	....	....
Cumberland	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Estill	5	....	....	....	....	1	....	....	....	....	4	....	....	....	....
Fentress	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Floyd	....	1	1	....	3	....	1	1	....	1	....	....	....	....	2
Johnson	....	....	....	1	....	....	....	....	1	....	....	....	....	....	....
Lawrence	....	....	1	6	1	....	....	1	4	1	....	....	....	2	....
Logan	....	....	....	8	1	....	....	....	1	....	....	....	....	7	1
McLean	....	....	1	....	....	....	....	1	....	....	....	....	....	....	....
Meade	....	....	1	1	....	....	....	....	1	....	....	....	1	....	....
Menifee	....	....	....	1	....	....	....	....	....	....	....	....	....	....	....
Morgan	....	....	2	....	....	....	....	2	....	....	....	....	....	....	....
Wayne	177	175	157	99	121	62	59	71	38	27	115	116	86	61	94
Welfe	26	21	7	4	2	7	5	2	4	....	19	16	5	....	1
Other	1	....	....	....	8	1	....	....	....	4	....	....	....	....	2
Total	213	200	171	121	136	[a] 75	[a] 65	[a] 79	[b] 50	[b] 33	138	135	92	70	100

[a] Including gas wells.

[b] Not including gas wells.

Number of wells completed in Kentucky and Tennessee, 1907–1911, by months.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total
1907	14	13	17	19	18	18	15	19	23	21	21	15	21
1908	13	15	20	16	21	18	18	17	15	20	11	16	20
1909	19	11	17	17	22	18	13	14	8	13	13	6	17
1910	4	10	3	11	13	18	17	9	9	11	9	7	12
1911	7	20	12	8	12	10	14	10	9	13	12	9	13

Number of dry holes drilled in Kentucky and Tennessee, 1907–1911, by months.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1907	5	3	9	4	6	4	4	7	8	8	9	8	[a] 75
1908	5	5	7	8	5	6	5	6	6	5	2	5	[a] 65
1909	9	2	8	5	9	7	5	6	5	10	11	2	[a] 79
1910	3	4	......	4	2	9	10	6	5	5	1	1	[b] 50
1911	4	5	5	2	1	1	6	2	......	3	1	3	[b] 33

[a] Including gas wells.

[b] Not including gas wells.

Total and average initial daily production of new wells in Kentucky and Tennessee, 1907–1911, by counties, in barrels.

County.	Total initial production.					Average initial production per well.				
	1907	1908	1909	1910	1911	1907	1908	1909	1910	1911
Bath and Rowan	......	14	......	......	......	......	4.7	......	......	......
Estill	40	......	......	......	......	10.0	......	......	......	......
Floyd	......	......	......	......	45	......	......	......	......	22.5
Lawrence	......	......	......	17	......	......	......	......	8.5	......
Logan	......	......	......	65	10	......	......	......	9.3	10.0
Meade	......	......	25	......	......	......	......	25.0	......	......
Wayne	2,121	2,167	2,111	747	1,729	18.4	18.7	24.5	12.2	18.4
Wolfe	250	261	50	......	25	13.2	16.3	10.0	......	25.0
Other	......	......	......	......	13	......	......	......	......	6.5
Total	2,411	2,442	2,186	829	1,822	17.5	18.1	23.8	11.8	18.2

Total initial daily production of new wells in Kentucky and Tennessee, 1907–1911, by months, in barrels.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1907	110	151	250	310	141	169	141	121	348	225	225	220	2,411
1908	200	195	378	127	265	151	199	196	195	242	147	147	2,442
1909	214	128	215	100	277	177	155	502	78	10	105	225	2,186
1910	15	110	50	73	149	97	69	60	33	54	81	38	829
1911	17	93	101	167	176	89	195	227	358	129	125	145	1,822

TENNESSEE.

Oil has been found in Tennessee in several widely separated localities. Of those in which most development work has been carried on, one centers in Pickett and Fentress counties and another in Overton County. Production has been at a standstill in recent years, but wildcatting has continued spasmodically. The general conditions of oil and gas occurrence in Tennessee have been described by M. J. Munn in Bulletin 2–E of the Tennessee Geological Survey, from which the following is abstracted:

Overton County.—Since 1866, when interest was first attracted to this county, spasmodic efforts have been made to develop an oil field on Spring Creek. Here oil is frequently found in cavities in the Fort Payne formation (Mississippian), of which there are from 100 to 200 feet above the black Chattanooga (Devonian) shale. The latter also shows gas and occasionally oil. Wildcatting is still being carried on in this territory. Other wells which have yielded considerable amounts of gas and are reported to have shown small amounts of oil have been drilled in Eldridge Cove, northeast of Spring Creek and near Oak Hill, and at Livingston, where a deep test to 2,000 feet gave only small "shows" of oil and gas. In the northern part of the county a number of wells were started in the top of the Chattanooga shale, most of the oil being found at less than 100 feet from the surface. The total quantity of oil obtained in the district probably has not exceeded a few barrels.

Pickett County.—The outcropping rocks in this region are Carboniferous, the lowest being the Fort Payne formation, of Mississippian age, and consisting of calcareous shale, a thin sandstone, some limestone, and bedded chert. Above the Fort Payne formation is a layer of 400 to 500 feet of Newman limestone. Below drainage underlying the Fort Payne formation occurs 25 to 30 feet of Chattanooga shale (Devonian), which lies unconformably upon Ordovician rocks, from which the oil and gas appear to come. Most of the oil is heavy and dark green to black, but several wells have yielded a light amber oil of excellent quality from oil sands. In this county two districts, the Spurrier and the Riverton fields, have been developed. In the latter, the Bob's Bar well, drilled in 1896 to a depth of 275 feet, yielded a large quantity of oil and led to the laying of a pipe line, which was finally taken up from lack of supply.

> The greatest apparent drawback for oil and gas in this district is the possible lack of good reservoir rocks. From the development work already done it seems probable that as a whole this area is one in which the processes of accumulation have been at work and that a large quantity of oil is present in the rocks at comparatively shallow depths. If this is true, and if good reservoir rocks, such as creviced beds of limestone and thin local beds of porous sandstone, exist here, it seems highly probable that other pools of commercial value are present.
>
> The most likely place at which oil and gas may have accumulated is probably dependent largely upon the general direction of movement of the underground waters. In regions of this kind the greatest number of pools are generally found at or near the axes of local anticlines at places where good reservoir rocks are present. In future development work it may therefore be found of great advantage to locate test wells only after the structure or lay of the beds has been accurately determined over a large area. This knowledge, together with the data available from the wells already drilled, should be sufficient to admit of each well being so located as to test the maximum amount of territory.
>
> With good facilities for transportation, both of the oil and of the materials used in development work, it seems possible that many pools of oil in this district may be profitably developed. From the data now at hand it is very probable that the creviced limestone will furnish many small pools under high pressure, thereby giving large daily production and short-lived wells. The amber oil horizons may prove to be local beds of porous sandstone or zones of fine broken residual chert along lines of unconformities which may be found to be sources of oil for many wells of small daily capacity and long lives.

Other counties.—Oil has been noted in a number of wells drilled in the belt of counties stretching from Pickett, Clay, and Scott counties on the Kentucky line, southwest through Fentress, Putnam, Cannon, Warren, Coffee, Carter, Bedford, Franklin, and Lincoln counties to the Alabama line and in the central basin. Oil, gas, salt water, and sulphur have been noted in several counties, including Marshall, Maury, Bedford, Rutherford, Wilson, Smith, and Davidson. Many counties farther to the west have also given indications of oil and gas, and from the facts pointed out in the State report, referred to above, there is probably an enormous quantity of oil scattered through the rocks of middle Tennessee. The testing tends to show that most of this is in pools too small to be of commercial value. The most favorable place of large accumulations of oil and gas seems to be the northern half of the Cumberland Plateau

First test here should be located on the axes or broad low anticlines. The wells should penetrate to about 300 feet below the Chattanooga shale. Many small though valuable accumulations of oil and gas are probably present in the creviced limestones of the Highland Plateau and in the southern part of Cumberland Plateau. This source of supply will eventually prove profitable when the greater fields of the United States are exhausted.

The occurrence of oil in southern Indiana and Illinois and the occurrence of gas in Mississippi River near Memphis have led to drilling for gas and oil in that region. Concerning this, George H. Ashley writes in an appendix to the report above quoted that in west Tennessee so few wells have at present been drilled that the fact that none of them have struck oil is itself of only negative value and should not weigh against the possibility of future success.

> With the present knowledge of the occurrence of oil and gas in Louisiana and Texas, it would seem: (1) That oil and gas probably exist in commercial quantities in the Tertiary and Cretaceous rocks of west Tennessee; (2) that such pools, if they exist, are probably quite small; (3) that wells striking oil there will probably be small producers, as compared with the gushers of Texas and Louisiana, but of greater length of life than those; (4) that until pools have actually been located and defined, nine out of ten or possibly ninety-nine out of a hundred wells may be unproductive, and the cost of their sinking of no value except as showing the lack of oil and gas, though their records, if carefully kept, may have some value in interpreting the underground conditions, particularly after oil has been struck.

ALABAMA.

In the early part of 1909 a diamond-drill hole about 2 miles east of the town of Fayette, Fayette County, Ala., in search of coal encountered two or more sands that furnished small quantities of oil within a depth of 475 feet from the surface. This led to the drilling of 2 deep test wells for oil and gas. On December 20, 1909, one of these wells encountered a gas-bearing sand at a depth of about 1,400 feet, yielding gas at an estimated rate of 1,600,000 cubic feet per day, with a closed pressure of about 630 pounds to the square inch. After a preliminary inspection M. J. Munn made a careful investigation of the field under a cooperative agreement between the United States Geological Survey and the Alabama Survey, the report of which constitutes chapter A-2 of Bulletin 471 of the United States Geological Survey.

Although the only economic product of the field thus far has been natural gas, the report contains much information concerning the probable occurrence of oil in this part of Alabama, from which the following has been taken:

> In the Fayette gas pool there is little available evidence to suggest the direction in which a pool of oil is most likely to occur in the gas sand. Such meager data as are at hand seem to slightly favor the NE. ¼ sec. 9 and to a much less degree the S. ½ SE. ¼ sec. 9 and adjoining parts of sec. 16.
>
> "Shows" of oil and gas have been noted in a number of sandstone beds in the wells of the Fayette district, and it is possible that some of these may be found to contain pools of oil of paying size in this vicinity. The most favorable indications for oil appear to have been found in sandstones relatively near the surface.
>
> A study of the core of Cosmos well No. 1 shows that enough oil has accumulated in the sandstone to form a pool and that it only lacks more pressure and a more porous pay sand to furnish wells of commercial size. In a theoretical way the data furnished by this core are intensely interesting. Beginning with No. 5 of this section, a bed of dark-gray shale is underlain by a massive green shale (No. 6), which grades downward into fine greenish micaceous sandstone (No. 7); this in turn changes abruptly to massive

> brown (discolored by oil) sandstone (No. 8), which is saturated with oil and is, so far as the writer could detect, of practically the same texture and hardness as No. 7, being, in fact, a continuation of that bed. This sandstone is continuous downward, unchanged except for a thin sandy shale parting (No. 9) which contains no oil. Below No. 9 the sequence described above is repeated, No. 10 being a dark fine-grained shale, No. 11 a massive greenish shale grading into massive gray micaceous sandstone (No. 12), and then into a coarser phase of the same bed (No. 13), saturated with oil, with a nonpetroliferous sandstone (No. 14) below. A study of this core section leads to the conclusion that these oil beds represent true accumulations and that lack of pressure behind the oil and of porosity in the sandstones in which it occurs may be the only reason why they do not furnish oil in commercial quantities. These facts suggest that this sandstone is oil bearing over a considerable area, and that in places where it is unusually coarse grained and porous small oil wells may be secured.
>
> Another zone which shows more or less oil in almost every well is marked by Nos. 22 and 24 in section F, No. 16 in section G, No. 17 in section H, No. 22 in section I, No. 24 in section J, Nos. 17 or 19 in section L, and No. 11 in section M. These general oil zones indicate that the process of accumulation has gone on to a certain extent in this vicinity, and also that the Carboniferous strata contain appreciable quantities of oil which at favorable places may have been gathered into valuable pools.
>
> The writer thinks it very probable that other and larger pools of gas and valuable pools of oil exist at places in the Warrior coal field. This belief is based on the age and character of the rocks which underlie this territory within reach of the drill. From these formations has been obtained a large part of the oil and gas of Oklahoma and much of that of West Virginia, southeastern Ohio, and portions of Pennsylvania. The general structure of the coal basin and the detailed structure, as shown by the small area mapped, are apparently as favorable as that of the great oil and gas regions mentioned above, with the possible exception that there may be too many faults in certain parts of the Warrior coal field to offer ideal conditions. From the scanty data available it seems that the general conditions governing the occurrence of underground water in this region are such as to offer almost ideal opportunities for this most important factor of oil and gas accumulation to exercise its function. These facts, taken in connection with the known existence of one gas pool (though it may be a small one) and the presence of more or less gas and oil in sandstones at a number of points (indicating that the rocks have an appreciable amount of these hydrocarbons scattered through them), seem to show that all the general geologic conditions considered essential for the formation of valuable accumulations of oil and gas are present in this region.

Munn suggests that the area lying north of the Fayette district has not received the attention from drillers that it deserves, though in making this suggestion he does not wish to minimize the value of testing in other directions.

> From what is at present known of the geologic conditions of this region it seems probable that the northern part of Fayette County, the western part of Walker County, the eastern part of Lamar County, at least the southern part of Marion County, and the western part of Winston County contain small areas in which all the structural conditions necessary to the occurrence of oil and gas are present. This suggestion is advanced in the hope that future wildcat drilling will be more evenly distributed over the western part of the Warrior field and adjacent parts of the Coastal Plain. Such testing will not only more quickly determine the value of this region for oil and gas but will also furnish valuable geologic data which may be used to great advantage in outlining the areas that are worthy of thorough testing.
>
> In this region no well should be considered a complete test unless it has penetrated 200 feet into the Chickamauga limestone, or at least has reached water in that formation, at points where the top of the limestone is less than 4,000 feet from the surface.
>
> The axes of broad anticlines in regions of this kind offer from 20 to probably more than 50 per cent advantage for wildcat wells over other structural positions, but the superiority of one anticline over another in a different part of the region is dependent on general geologic conditions, the determination of which was beyond the scope of this work.

OHIO.

The event of chief interest in the Ohio oil field in 1911, was the extension of the eastern fields toward the middle line of the State. It had become evident to the natural-gas companies that the declining gas supply in northwestern Ohio might be compensated to some extent by drilling into the Clinton sands on the western edge of the eastern Ohio oil fields. The occurrence of oil and gas in the Clinton sand in Ohio was described in the report for 1909. In that year and in 1910 and 1911 drilling to the Clinton sand for gas was carried farther and farther west. In many instances oil (of Pennsylvania grade) was found as well as large gas wells, so that the returns justified the great outlay for deep wells and also encouraged prospecting to the north. The excitement began in 1910 with the development of oil in the Bremen-Junction City field in Fairfield County. This led to wildcatting near New Straitsville in the southwestern part of Perry County. The oil wells thus developed were sufficient to bring the older companies into the district and the field was extended into the Falls Gore township of Hocking County. The wells are fairly productive and show good staying qualities. Drilling next extended in the southwestern part of Muskingum County and the southeastern part of Licking County near Gratiot. Drilling then continued northward with success near Frazeysburg in northwestern Muskingum County, and adjoining in Licking County. Then development kept on to the north near West Carlisle in Coshocton County and in adjoining territory in Knox County. Since this the drilling excitement, with some success, has extended north to Butler, in Richland County, to Oberlin, Lorain County; east of this near Litchfield, in Medina County, and near Wooster, in Wayne County. Perhaps greatest interest was aroused by finding a small oil supply in a well at Newburg, in the suburbs of Cleveland. In this locality and to the west of Cleveland along the lake shore, shallow gas wells have been drilled for over 40 years, sufficient gas being found in the lake shales to supply several houses from each well. Much leasing has now been done in this region and much deep drilling has been commenced. The Clinton sand developments cover a north-south distance of over 100 miles and a large number of wells will be drilled in 1912 to test the region properly.

In southeastern Ohio drilling was active but the known areas were not greatly extended.

The Lima fields in northwestern Ohio cover parts of the following counties: Allen, Auglaize, Hancock, Hardin, Lucas, Mercer, Ottawa, Putnam, Sandusky, Seneca, Van Wert, Wood, and Wyandot.

Drilling was not active. The only discovery of unusual interest was the finding of oil near Tiffin, in Seneca County, at much greater depth than usual. Oil is looked for ordinarily at about 100 feet below the top of the Trenton limestone, but northeast of the old territory oil has been found at 650 feet below the top of the Trenton—or 2,300 feet from the surface, almost the depth of the Clinton sand to the east.

There was also a slight extension, almost 2 miles, to the west in Wood County. The known areas were also extended in Mercer, Van Wert, and Auglaize counties. Prospecting has begun to the south of the Lima field in Hardin and other counties. On the whole, drilling and production showed a decline in the Lima field.

PRODUCTION.

Production declined from 9,916,370 barrels in 1910 to 8,817,112 barrels in 1911, or 10.98 per cent. This decrease was almost entirely in the Lima field, where the rate was 14.2 per cent, as shown in the following tables.

In the following table is given the production of petroleum in Ohio, by months and districts, for the year 1911:

Production of petroleum in Ohio in 1911, by months and districts, in barrels.

Month.	Lima.	South-eastern Ohio.	Mecca-Belden.	Total.
January	395,132	346,170	....	741,302
February	364,706	341,747	....	706,453
March	413,321	372,270	....	785,591
April	380,434	345,162	....	725,596
May	405,705	383,774	....	789,479
June	393,385	371,118	....	764,503
July	367,216	341,297	....	708,545
August	383,440	364,106	....	747,578
September	365,586	352,353	....	717,939
October	376,118	358,100	....	734,218
November	330,800	343,691	....	674,491
December	360,032	361,385	....	721,417
Total	4,535,875	4,281,173	64	8,817,112

The quantity and value of petroleum produced in Ohio from 1902 to 1911, inclusive, by districts, are shown in the following table:

Quantity and value of petroleum produced in Ohio, 1902–1911, by districts, in barrels.

Year.	Lima.		Southeastern Ohio.		Mecca-Belden.		Total.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
1902	15,877,730	$14,284,072	5,136,366	$6,471,821	135	$1,466	21,014,231	$20,757,359
1903	14,893,853	17,351,339	5,585,858	8,881,514	575	1,668	20,480,286	26,234,521
1904	13,350,060	14,735,129	5,526,146	8,993,803	425	1,583	18,876,631	23,730,515
1905	11,329,924	10,061,992	5,016,646	6,991,950	90	935	16,346,660	17,054,877
1906	9,881,184	9,157,641	4,906,399	7,838,387	180	972	14,787,763	16,997,000
1907	7,993,057	7,425,480	4,214,298	7,343,943	93	465	12,207,448	14,769,888
1908	6,748,676	6,861,885	4,109,935	7,315,667	186	950	10,858,797	14,178,502
1909	5,915,357	5,451,497	4,717,069	7,771,555	367	2,325	10,632,793	13,225,377
1910	5,094,136	4,181,629	4,822,193	6,469,314	41	625	9,916,370	10,651,568
1911	4,535,875	3,888,119	4,281,173	5,590,457	64	966	8,817,112	9,479,542

WELL RECORD.

Number of wells completed in central and southeastern Ohio oil fields in 1911, by counties and months.[a]

County.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Total.
Ashland (Lake, Miflin, Milton, Mohican, Montgomery, and Vermillion districts)	2	1	3	3	6	6	13	5	13	16	15	17	100
Carroll (Norristown district)	5	5	3	2	1	3	6	1	3	2	2	3	36
Columbiana (Alliance district)	4	7	2	1	2	4	5	2	7	3	5	2	44
Coshocton (Bedford, Clay, Pike, and Washington districts)	1	2	...	5	4	...	...	...	1	...	2	2	17
Cuyahoga (Newbury and Rocky River districts)	...	...	...	...	...	...	...	...	...	1	1	...	2
Delaware (Harlem district)	...	...	1	...	...	...	...	...	...	...	...	...	1
Erie (Florence district)	...	...	...	...	...	...	...	...	1	...	...	...	1
Fairfield (Berne, Clear Fork, Greenfield, Pleasants, Rush Creek, Rushville, Upper Walnut, and Walnut districts)	6	5	30	6	9	11	8	9	5	9	14	3	115
Harrison (Cadiz, Plum Run, and Scio districts)	3	...	1	1	...	1	1	3	...	4	3	...	17

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[a] Including gas wells.

Number of wells completed in central and southeastern Ohio oil fields in 1911, by counties and months—Continued.

County.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Total.
Hocking (Falls, Laurel, Marion, Keller, and Perry districts)	8	6	1	3	7	5	7	7	12	12	10	14	92
Holmes (Killbuck and Washington districts)	...	...	1	...	...	...	...	...	1	...	1	1	4
Jackson (Scioto district)	...	...	...	...	...	...	...	...	1	...	...	...	1
Jefferson (Steubenville district)	7	3	8	6	7	5	9	12	2	9	4	7	79
Knox (Clay, Gambier, College, and Pleasants districts)	5	...	7	...	2	2	1	...	2	11	7	7	44
Licking (Avondale, Black Hand, Buckeye, Burlington, Eden, Fallsburg, Granville, Hanover, Hebron, Hopewell, Jacksontown, Liberty, Licking, Madison, Mary Ann, Newton, Perry, Shell Beach, Thornport, Union, Washington, and McKean districts)	25	17	12	8	10	16	13	8	16	10	18	11	164
Lorain (Pittsfield, Russia, and Sheffield districts)	...	...	...	...	...	...	...	...	...	1	3	2	6
Medina (Harrisville, Homer, Litchfield, Medina, Pleasants, Westfield, and York districts)	1	1	2	...	2	...	3	2	...	2	1	...	14
Monroe (Barnesville, Graysville, Jackson Ridge, Jerusalem, Lewisville, Miller's Run, Newcastle, Rinard Mills, and Woodsfield districts)	12	7	6	10	6	8	7	12	9	8	3	10	98
Morgan (Chester Hill district)	6	7	6	12	18	20	17	19	7	27	17	16	172
Muskingum (Fultonham, Hopewell, Monroe, Muskingum, and Newton districts)	...	4	...	1	1	5	2	4	6	2	2	1	28
Noble (Macksburg district)	8	12	14	14	11	14	19	15	13	15	16	12	163
Perry and Athens (Clay, Corning, Harrison, Marion, Monday Creek, Reading, and Thorn districts)	24	20	5	11	10	8	8	10	8	11	17	8	140
Richland (Monroe district)	...	2	...	...	...	...	...	...	...	...	...	1	3
Ross (Harper Station district)	...	...	...	...	...	...	...	1	...	...	...	...	1
Vinton (Near Hue, Benton, Knox, and Litchfield districts)	1	...	...	...	...	...	1	...	...	2	1	3	8
Washington (Macksburg, Marietta, and New Matamoras districts)	20	22	19	31	32	42	29	23	35	17	29	25	324
Wayne (Clinton, Congress, Plain, and Wayne districts)	...	...	...	...	1	1	...	...	2	...	1	1	6
Total	138	121	121	114	129	151	149	133	144	162	172	146	1,680

Number of oil wells and dry holes drilled in central and southeastern Ohio oil fields in 1911, by counties and months.

County.	Jan.		Feb.		Mar.		Apr.		May.		June.		July.		Aug.		Sept.		Oct.		Nov.		Dec.		Total.	
	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.
Ashland (Lake, Jackson, Miflin, Milton, Mohican, Montgomery, and Vermilion districts)	..	...	..	...	..	1	..	...	..	1	...	...	...	2	..	...	...	2	..	2	..	...	..	4	...	12
Carroll (Norristown district)	1	4	2	2	..	2	1	1	1	...	1	1	...	5	..	1	1	2	1	1	..	1	2	...	10	20
Columbiana (Alliance district)	1	3	2	5	1	1	..	1	..	2	2	2	2	3	1	1	2	5	..	3	2	3	1	1	14	30
Coshocton (Bedford, Pike, and Washington districts)	..	...	1	1	..	...	1	4	..	2	...	...	...	...	..	...	1	...	..	...	2	...	2	...	7	7
Cuyahoga (Newburg district)	..	...	..	...	..	...	..	...	..	...	...	...	...	...	..	...	...	...	1	...	..	...	..	...	1	...
Delaware (Harlem district	..	...	..	...	..	1	..	...	..	...	...	...	...	...	..	...	...	...	..	...	..	...	..	...	...	1
Fairfield (Berne, Clear Fork, Greenfield, Pleasants, Richland, and Walnut districts)	..	1	..	...	15	10	2	4	7	1	3	8	4	3	6	3	4	...	7	1	6	4	3	...	57	35
Harrison (Cadiz, Plum Run, and Scio districts)	2	1	..	...	1	...	1	...	...	...	...	1	1	...	2	1	...	...	2	1	1	...	..	...	10	4
Hocking (Falls, Laurel, Marion, and Perry districts)	..	2	..	...	..	1	2	...	4	1	2	...	2	1	5	1	7	3	1	2	4	1	11	..	38	12
Holmes (Killbuck district)	..	...	..	...	..	1	..	...	..	...	...	...	...	...	..	...	...	...	..	...	..	1	..	1	...	3
Jackson (Scioto district)	..	...	..	...	..	...	..	...	..	...	...	...	...	...	..	...	...	1	..	...	..	...	..	...	...	1

Number of oil wells and dry holes drilled in central and southeastern Ohio oil fields in 1911, by counties and months—Continued.

County.	Jan.		Feb.		Mar.		Apr.		May.		June.		July.		Aug.		Sept.		Oct.		Nov.		Dec.		Total.	
	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.
Jefferson (Steubenville district)	1	3	3	...	3	3	1	1	3	3	1	2	3	2	4	6	1	1	5	4	1	2	2	4	28	31
Knox (Clay, College, and Pleasants districts)	..	2	..	...	..	3	..	...	..	...	...	...	...	1	..	...	...	...	..	3	..	1	..	1	...	11
Licking (Avondale, Buckeye, Burlington, Eden, Fallsburg, Granville, Hebron, Hopewell, Jacksontown, Liberty, Licking, Madison, Newton, Perry, Thornport, Union, Washington, and McKean districts)	..	5	1	4	1	3	..	2	..	3	...	4	...	3	..	2	2	...	..	2	1	2	1	4	6	34
Lorain (Pittsfield, Russia, and Sheffield districts)	..	...	..	...	..	...	..	...	..	...	...	...	...	...	..	...	...	...	..	...	1	...	..	2	1	2
Medina (Homer, Litchfield, Westfield, and York districts))	1	...	..	...	..	1	..	...	..	1	...	...	...	1	..	1	...	...	..	...	..	...	..	...	1	4
Monroe (Barnesville, Graysville, Jackson Ridge, Jerusalem, Lewisville, Millers Run, Newcastle, Rinard Mills, and Woodsfield districts)	8	3	4	3	5	1	4	4	..	4	5	1	1	5	5	6	3	2	5	3	1	2	2	8	43	42
Morgan (Chester Hill district)	5	1	5	2	5	1	8	4	12	6	15	5	12	5	10	9	3	4	19	8	12	5	11	5	117	55
Muskingum (Hopewell, Monroe, and Newton districts)	..	...	2	1	..	...	..	...	..	1	...	4	1	1	1	3	2	2	1	...	2	...	..	...	9	12
Noble (Macksburg district)	5	3	8	4	11	3	9	4	5	5	9	5	9	10	5	9	8	5	7	6	11	5	8	3	95	62
Perry and Athens (Corning, Harrison, Monday Creek, Reading, and Thorn districts)	21	3	16	4	2	3	11	...	8	2	7	1	4	4	6	4	6	1	7	4	12	4	7	1	107	31
Richland (Monroe district)	..	...	..	...	..	...	..	...	..	...	...	...	...	...	..	...	...	...	..	...	..	...	..	1	...	1
Ross (Harper Station district)	..	...	..	...	..	...	..	...	..	...	...	...	...	...	1	...	...	...	..	...	..	...	..	...	1	...
Vinton (Near Hue, Knox, and Litchfield districts)	..	1	..	...	..	...	..	...	..	...	...	...	1	...	..	...	...	...	2	...	..	...	1	1	4	2
Washington (Macksburg, Marietta, and New Matamoras districts)	16	4	15	6	13	6	21	8	25	6	26	15	17	10	15	6	26	8	9	8	15	13	17	8	215	98
Wayne (Clinton, Congress, Plain, and Wayne districts)	..	...	..	...	..	...	..	...	..	...	...	1	...	...	..	...	...	...	..	...	..	1	1	...	1	2
Total	61	36	59	32	57	41	61	33	65	38	71	50	57	56	61	53	66	36	67	48	71	45	69	44	765	512

Initial daily production of new wells completed in central and southeastern Ohio oil fields in 1911, by counties and months, in barrels.

County.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
Carroll (Norristown (district)	5	53	...	3	5	3	...	...	5	1	....	5	80
Columbiana (Alliance district)	1	2	2	...	.....	23	12	3	10	...	15	1	69
Coshocton (Bedford, Pike, and Washington districts)	...	20	...	5	.....	...	...	...	15	...	25	35	100
Cuyahoga (Newburg district)	...	...	...	...	.....	...	...	...	...	10	....	....	10
Fairfield (Berne, Clear Fork, Greenfield, Pleasants, and Walnut districts)	...	...	345	20	247	15	60	70	60	105	48	70	1,040
Harrison (Cadiz, Plum Run, and Scio districts)	10	...	2	2	.....	...	3	5	...	8	5	....	35
Hocking (Fålls, Laurel, Marion, and Perry districts)	...	...	...	65	310	50	105	96	220	60	110	370	1,386
Jefferson (Steubenville district)	1	11	8	2	4	1	4	13	20	15	10	2	91
Licking (Avondale, Buckeye, Burlington, Eden, Fallsburg, Granville, Hebron, Hopewell, Jacksontown, Liberty, Licking, Madison, Newton, Perry, Thornport, Union, Washington, and McKean districts)	...	3	15	...	.....	...	...	...	35	...	15	75	143
Lorain (Russia district)	...	...	...	...	.....	...	...	...	...	...	10	....	10
Medina (Litchfield district)	35	...	...	...	.....	...	...	...	...	...	....	....	35
Monroe (Barnesville, Graysville, Jackson Ridge, Jerusalem, Lewisville, Millers Run, Newcastle, Rinard Mills, and Woodsfield districts)	110	64	42	35	....	24	10	42	27	28	2	9	393
Morgan (Chester Hill district)	50	75	100	105	154	125	136	279	60	136	161	107	1,488
Muskingum (Hopewell, Monroe, and Newton districts)	...	105	...	...	.....	...	5	3	8	2	105	....	228
Noble (Macksburg district)	20	17	43	37	12	50	22	8	29	25	30	32	325
Perry and Athens (Corning, Harrison, Monday Creek, Reading, and Thorn districts)	519	535	6	195	242	195	125	125	166	405	908	260	3,681
Ross (Harper Station district)	...	...	...	...	.....	...	...	5	...	...	....	....	5
Vinton (Near Hue, Knox, and Litchfield districts)	...	...	...	...	.....	...	5	...	...	70	....	2	77
Washington (Macksburg, Marietta, and New Matamoras districts)	131	88	103	218	248	223	90	123	240	51	82	105	1,702
Wayne (Wooster district)	...	...	...	...	.....	...	...	...	...	...	....	25	25
Total	882	973	666	687	1,222	709	577	772	895	916	1,526	1,098	10,923

Total initial daily production of new wells in southeastern Ohio oil field, 1907–1911, by months, in barrels.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.	Average.
1906	847	1,026	1,019	751	1,102	1,022	1,226	1,982	2,179	716	692	852	13,414	1,118
1907	802	170	185	436	697	765	617	850	584	555	641	608	6,910	576
1908	675	347	172	541	798	1,050	625	1,649	2,774	2,413	2,113	1,174	14,331	1,194
1909	2,054	2,490	1,739	1,794	2,490	3,652	2,629	2,131	1,737	2,206	1,971	1,259	26,152	2,179
1910	1,319	1,440	2,388	2,747	2,314	2,065	1,296	872	1,045	1,135	775	642	18,038	1,503
1911	847	835	651	687	1,222	699	567	767	840	856	1,376	968	10,315	860

LIMA-INDIANA OIL FIELD.

PRODUCTION.

In the following table will be found the production of the Lima-Indiana field, by States and months, for the year 1911:

Production of petroleum in the Lima-Indiana field in 1911, by months, in barrels.

Month.	Lima, Ohio.	Indiana.	Total.
January	395,132	146,582	541,714
February	364,706	135,064	499,770
March	413,321	355,552	768,873
April	380,434	133,947	514,381
May	405,705	139,302	545,007
June	393,385	132,096	525,481
July	367,216	120,737	487,953
August	383,440	122,416	505,856
September	365,586	114,109	479,695
October	376,118	107,317	483,435
November	330,800	89,007	419,807
December	360,032	99,160	459,192
Total	4,535,875	1,695,289	6,231,164

In the following table will be found the production of the Lima-Indiana field from 1902 to 1911, inclusive, with its percentage of the total production of the United States, the increase or decrease made each year, and the percentage of increase or decrease:

Production of petroleum in the Lima-Indiana field, 1902–1911.

Year.	Production, in barrels.	Per centage of total production.	Increase.	Decrease.	Percentage.	
					Increase.	Decrease.
1902	23,358,826	26.31	1,425,197		6.50	
1903	24,080,264	23.97	721,438		3.09	
1904	24,689,184	21.09	608,920		2.53	
1905	22,294,171	16.55		2,395,013		9.70
1906	17,554,661	13.88		4,739,510		21.26
1907	13,121,094	7.90		4,433,567		25.26
1908	10,032,305	5.62		3,088,789		23.54
1909	8,211,443	4.48		1,820,862		18.15
1910	7,253,861	3.46		957,582		11.66
1911	6,231,164	2.83		1,022,697		14.10

Production and value of petroleum in the Lima-Indiana field, 1907–1911, in barrels.

Year.	North Lima, Ohio.		South Lima, Ohio.		Indiana.		Total.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
1907	6,399,917	$6,016,238	1,593,140	$1,409,242	5,128,037	$4,536,930	13,121,094	$11,962,410
1908	5,430,124	5,574,400	1,318,552	1,287,485	3,283,629	3,203,883	10,032,305	10,065,768
1909	4,761,065	4,434,277	1,154,292	1,017,220	2,296,086	1,997,610	8,211,443	7,449,107
1910	4,131,060	3,431,618	963,076	750,011	2,159,725	1,568,475	7,253,861	5,750,104
1911	3,676,397	3,221,308	859,478	666,811	1,695,289	1,228,835	6,231,164	5,116,954

PIPE-LINE RUNS AND DELIVERIES AND STOCKS IN LIMA-INDIANA OIL FIELD.

In the following tables are given the pipe-line runs, deliveries, and stocks on hand in the Lima-Indiana field in 1911:

Pipe-line runs in the Lima-Indiana oil field in 1911, by months, in barrels.

Month.	Buckeye pipe line.	Other Ohio.	Indiana pipe line.	Other Indiana.	Total.
January	298,660	96,472	97,175	49,407	541,714
February	271,487	93,219	93,931	41,133	499,770
March	312,222	101,099	105,206	250,346	768,873
April	284,518	95,916	96,153	37,794	514,381
May	306,936	98,769	102,912	36,390	545,007
June	296,419	96,966	99,230	32,866	525,481
July	275,578	91,638	90,837	29,900	487,953
August	285,940	97,500	92,894	29,522	505,856
September	271,762	93,824	87,609	26,500	479,695
October	281,829	94,289	82,114	25,203	483,435
November	247,696	83,104	68,151	20,856	419,807
December	264,529	95,503	77,825	21,335	459,192
Total	3,397,576	1,138,299	1,094,037	601,252	6,231,164

Pipe-line deliveries of petroleum in the Lima-Indiana oil field in 1911, by months, in barrels.

Month.	Buckeye pipe line.	Indiana pipe line.	Other.[a]	Total.
January	281,254	1,040,194	161,290	1,482,738
February	283,399	765,520	161,290	1,210,209
March	336,407	719,269	161,290	1,216,966
April	433,113	547,099	161,290	1,141,502
May	329,550	835,186	161,291	1,326,027
June	274,971	864,627	161,291	1,300,889
July	317,344	865,508	161,291	1,344,143
August	242,557	867,952	161,290	1,271,799
September	339,232	908,639	161,290	1,409,161
October	375,032	855,649	161,290	1,391,971
November	269,891	910,330	161,290	1,341,511
December	201,231	923,790	161,290	1,286,311
Total	3,683,981	10,103,763	1,935,483	15,723,227

[a] Averaged.

Gross stocks of crude petroleum in the Lima-Indiana oil field in 1911, by months, in barrels.

Month.	Buckeye pipe line.	Indiana pipe line.	Other.	Total.
January	5,467,277	849,135	....	....
February	5,636,772	992,148	....	....
March	5,674,986	1,014,489	....	....
April	5,697,098	935,880	....	....
May	5,059,901	955,327	....	....
June	5,463,980	1,023,033	....	....
July	5,311,093	947,627	....	....
August	5,102,865	899,630	....	....
September	4,934,634	719,541	....	....
October	4,237,205	858,206	....	....
November	4,057,418	922,574	....	....
December	4,066,820	965,890	54,131	5,086.841

PRICES OF PETROLEUM IN LIMA-INDIANA FIELD.

In the following table are given the fluctuations in prices for the various grades of Lima and Indiana oil in 1910 and 1911. The dates are those on which changes in prices were made.

Fluctuations in prices of Lima (Ohio) and Indiana petroleum in 1910 and 1911, per barrel.

Date.	1910			Date.	1911		
	North Lima.	South Lima and Indiana.	Princeton, Ind.		North Lima.	South Lima and Indiana.	Princeton, Ind.
Jan. 1	$0.84	$0.79	$0.60	Jan. 1	$0.82	$0.77	$0.60
June 11	.82	.77	.60	May 2	.82	.77	.63
				June 14	.82	.77	.65
				Sept. 15	.84	.79	.67

In the following table are given the average monthly prices of Lima (Ohio) and Indiana petroleum, per barrel of 42 gallons each, in the years 1909 to 1911:

Average monthly prices of Ohio and Indiana petroleum in 1909, 1910, and 1911, per barrel.

Month.	1909			1910			1911		
	North Lima.	South Lima and Indiana.	Princeton, Ind.	North Lima.	South Lima and Indiana.	Princeton, Ind.	North Lima.	South Lima and Indiana.	Princeton, Ind.
January	$1.04	$0.99	$0.68	$0.84	$0.79	$0.60	$0.82	$0.77	$0.60
February	1.04	.99	.68	.84	.79	.60	.82	.77	.60
March	1.04	.99	.68	.84	.79	.60	.82	.77	.60
April	1.04	.99	.68	.84	.79	.60	.82	.77	.60
May	.96	.91	.68	.84	.79	.60	.82	.77	.63
June	.93¼	.88¼	.67½	.82¾	.77¾	.60	.82	.77	.64
July	.87⅜	.82⅜	.63⅜	.82	.77	.60	.82	.77	.65
August	.86	.81	.62	.82	.77	.60	.82	.77	.65
September	.86	.81	.62	.82	.77	.60	.83	.78	.66
October	.85¼	.80¼	.61¼	.82	.77	.60	.84	.79	.67
November	.84	.79	.60	.82	.77	.60	.84	.79	.67
December	.84	.79	.60	.82	.77	.60	.84	.79	.67
Average	.93⅛	.88⅛	.64⅝	.82⅞	.77⅞	.60	.826	.776	.637
Average of North Lima, South Lima, and Indiana	.90⅝			.80⅜			.801		

In the following table will be found the highest, lowest, and average prices of Lima (Ohio) oil for the last 10 years:

Highest, lowest, and average prices of Lima (Ohio) petroleum, 1902–1911, per barrel.

Year.	Highest.	Lowest.	Average.	Year.	Highest.	Lowest.	Average
1902	a $1.15	b $0.80	$0.88¼	1907	a $0.94	b $0.85	$0.90
1903	a 1.38	b 1.06	1.16½	1908	a 1.04	b .89	1.00
1904	a 1.36	b .95	1.10⅜	1909	a 1.04	b .79	.90
1905	a 1.01	b .81	.88¾	1910	a .84	b .77	.80
1906	a .98	b .85	.91⅛	1911	a .84	b .77	.80

a North Lima.

b South Lima.

WELL RECORD.

In the following tables are given the well records for the Lima (Ohio) oil field from 1907 to 1911, inclusive:

Number of wells completed in the Lima (Ohio) district, 1907–1911, by counties.

County.	Completed.					Dry.					Oil.				
	1907	1908	1909	1910	1911	1907	1908	1909	1910	1911	1907	1908	1909	1910	1911
Allen	34	61	79	13	21	4	1	4	1	....	30	60	75	12	21
Auglaize	8	8	15	22	18	3	....	4	5	4	5	8	11	17	12
Hancock	121	92	111	125	113	20	9	5	8	2	101	83	106	114	104
Hardin	....	....	....	5	2	....	....	....	....	....	....	....	....	2	2
Henry	....	....	1	....	....	....	....	....	....	....	....	....	1	....	....
Lucas	40	34	21	7	22	3	4	....	....	1	37	30	21	7	21
Mercer	21	8	6	5	12	2	1	1	1	2	19	7	5	4	9
Ottawa	57	44	57	25	18	4	2	4	1	3	53	42	53	23	14
Putnam	....	....	....	1	2	....	....	....	....	....	....	....	....	1	2
Sandusky	212	162	116	71	58	24	12	9	5	2	188	150	107	64	56
Seneca	41	81	83	54	44	6	21	12	7	8	35	60	71	47	35
Van Wert	42	108	83	20	24	11	4	8	2	1	31	104	75	18	23
Wood	258	229	282	217	191	28	17	29	26	9	230	212	253	189	179
Wyandot	60	19	9	5	2	22	7	....	1	....	38	12	9	3	2
Miscellaneous	12	2	9	2	....	9	2	9	....	....	3	....	....	....	....
Total	906	848	872	572	527	[a]136	[a] 80	[a] 85	[b] 57	[b] 32	770	768	787	501	480

[a] Including gas wells.

[b] Not including gas wells.

Number of wells completed in the Lima (Ohio) district, 1907–1911, by months.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1907	69	44	86	84	76	84	92	82	81	71	75	62	906
1908	60	26	46	49	62	66	88	88	98	95	84	86	848
1909	98	59	78	86	70	92	72	78	71	64	63	41	872
1910	29	27	31	46	55	57	59	56	54	44	69	45	572
1911	45	48	40	40	44	48	42	46	50	44	47	33	527

Number of dry holes drilled in the Lima (Ohio) district, 1907–1911, by months.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1907	14	6	13	26	8	10	10	7	8	13	8	13	[a] 136
1908	8	2	9	6	6	7	9	3	10	6	5	9	[a] 80
1909	9	4	11	6	6	7	4	7	5	6	14	6	[a] 85
1910	5	2	4	4	6	6	7	5	5	4	5	4	[b] 57
1911	3	4	1	....	4	5	4	3	....	2	4	2	[b] 32

[a] Including gas wells.

[b] Not including gas wells.

Total and average initial daily production of new wells in the Lima (Ohio) district, 1907–1911, by counties, in barrels.

County.	Total initial production.					Average initial production per well.				
	1907	1908	1909	1910	1911	1907	1908	1909	1910	1911
Allen	284	694	708	110	171	9.5	11.6	9.4	9.2	8.1
Auglaize	22	75	138	306	174	4.4	9.4	12.5	18.0	14.5
Hancock	1,090	1,042	1,253	1,505	1,546	10.8	12.6	11.8	13.2	14.9
Hardin	....	....	....	13	25	....	....	....	6.5	12.5
Henry	....	....	5	....	....	....	....	5.0	....	....
Lucas	433	327	203	116	412	11.7	10.9	9.7	16.6	19.6
Mercer	220	55	35	65	60	11.6	7.9	7.0	16.3	6.7
Ottawa	479	336	450	183	108	9.0	8.0	8.5	8.0	7.7
Putnam	....	....	....	3	12	....	....	....	3.0	6.0
Sandusky	1,061	822	561	422	312	5.6	5.5	5.2	6.6	5.6
Seneca	664	800	582	737	341	19.0	13.3	8.2	15.7	9.7
Van Wert	361	1,268	639	192	369	11.6	12.2	8.5	10.7	16.0
Wood	2,128	3,067	3,423	3,003	2,836	9.2	14.5	13.5	15.9	15.8
Wyandot	1,087	235	121	90	15	28.6	19.6	13.4	30.0	7.5
Miscellaneous	23	....	....	....	....	7.7	....	....	....	....
Total	7,852	8,721	8,118	6,745	6,381	10.2	11.4	10.3	13.5	13.3

Total initial daily production of new wells in the Lima (Ohio) district, 1907–1911, by months, in barrels.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1907	460	523	849	699	687	593	698	575	653	1,012	527	576	7,852
1908	886	267	338	499	452	464	680	862	944	1,443	990	896	8,721
1909	1,067	767	567	678	480	900	606	853	626	718	513	343	8,118
1910	377	425	500	530	565	447	684	735	794	441	723	524	6,745
1911	508	599	323	483	460	559	498	630	470	793	465	593	6,381

In the following tables are given the number of oil wells abandoned in the Lima-Indiana oil field from June, 1905, to December 31, 1911, inclusive:

Number of oil wells abandoned in the Indiana oil fields and in Lima (Ohio) oil field from June, 1905, to December, 1911, by months.

Month.	1905	1906	1907	1908	1909	1910	1911	Total.
January	....	54	45	75	149	61	62	44
February	....	74	83	59	108	66	21	41
March	....	27	49	129	237	221	114	77
April	....	47	129	198	98	140	31	64
May	....	100	194	358	204	157	233	1,24
June	28	82	143	207	347	146	118	1,07
July	53	50	111	191	157	176	141	87
August	54	147	170	228	322	126	122	1,16
September	19	87	157	195	267	294	79	1,09
October	158	139	181	144	201	80	137	1,04
November	53	139	177	155	172	100	160	95
December	66	117	62	220	156	128	41	79
Total, Indiana	431	1,063	1,501	2,159	2,418	1,695	1,259	10,52
Total, Lima, Ohio	674	1,059	1,357	1,135	1,127	1,500	1,142	7,99
Total, Lima-Indiana	1,105	2,122	2,858	3,294	3,545	3,195	2,401	18,52

Number of oil wells abandoned in the Lima-Indiana oil field, June, 1905, to Dec. 31, 1911, by counties.

Lima, Ohio.		Indiana.	
County.	Number of wells.	County.	Number of wells.
Allen	1,600	Adams	579
Auglaize	708	Blackford	1,179
Darke	4	Delaware	1,138
Hancock	1,102	Gibson	1
Lucas	314	Grant	3,348
Mercer	265	Hamilton	4
Ottawa	90	Huntington	619
Putnam	17	Jay	397
Sandusky	627	Madison	87
Seneca	108	Marion	15
Shelby	8	Miami	49
Van Wert	499	Randolph	196
Wood	2,450	Wabash	16
Wyandot	202	Wells	2,898
Total	7,994	Total	10,526

INDIANA.

PRODUCTION.

The chief oil fields of Indiana constitute an extension of the fields in northwestern Ohio where the oil is found in Ordovician limestone. This limestone outcrops on the eastern edge of the State and dips to the west under the younger rocks. Oil and gas have been found in an irregular area covering 15 counties with Miami County as the northern limit and Shelby County on the south and extending as far west as Clinton County. In the valley of Kankakee River in northwestern Indiana, small quantities of heavy oil have been found. Within the last three years much prospecting for oil and gas has been carried on in southwestern Indiana in the hope of extending the Illinois fields into Indiana. The result has been the opening of a small pool of oil with some gas in Pike and Gibson counties, known as the Oakland City pool. Prospecting has also been active in Knox, Daviess, and Green counties, with slight development of oil and gas. Oil and gas seepages are so frequent in many parts of the State that much more prospecting will undoubtedly be carried on for the next few years.

In spite of considerable exploratory work, and the development of the Oakland City pool, Indiana production declined from 2,159,725 barrels in 1910 to 1,695,289 barrels in 1911. The price shared in the general increase in values of the adjoining fields. The great decline in gas pressures increased the cost of pumping the oil wells and this hastened the abandoning of many small wells, though many still less productive wells are operated in Pennsylvania because there gas can be had practically without cost. Only 117 new wells were drilled in the State during the year; five years ago over 2,000 were drilled annually. Both oil and gas wells are being abandoned rapidly.

The tables of production which follow give details of the marked decline in 1911.

Production and value of petroleum in Indiana, 1902–1911, in barrels.

Year.	Quantity.	Value.	Price per barrel.
1902	7,480,896	$6,526,622	$0.87
1903	9,186,411	10,474,127	1.14
1904	11,339,124	12,235,674	1.08
1905	10,964,247	9,404,909	.86
1906	7,673,477	6,770,066	.88
1907	5,128,037	4,536,930	.88
1908	3,283,629	3,203,883	.98
1909	2,296,086	1,997,610	.87
1910	2,159,725	1,568,475	.73
1911	1,695,289	1,228,835	.74

Production of petroleum in Indiana, 1907–1911, by months, in barrels.

Month.	1907	1908	1909	1910	1911
January	483,994	323,620	202,055	143,481	146,582
February	451,111	262,189	182,914	136,388	135,064
March	458,119	296,478	221,455	163,588	355,552
April	468,057	302,416	211,265	161,865	133,947
May	481,895	302,290	212,575	178,582	139,302
June	438,428	292,156	211,981	292,521	132,096
July	461,912	289,040	205,182	219,210	120,737
August	427,877	269,667	198,306	200,681	122,416
September	380,269	259,162	184,207	179,536	114,109
October	368,568	241,468	172,505	169,338	107,317
November	349,238	219,348	170,871	159,878	89,007
December	340,569	225,795	122,770	154,657	99,160
Total	5,128,037	3,283,629	2,296,086	2,159,725	1,695,289

WELL RECORD.

In the following tables is given the well record for Indiana from 1907 to 1911, inclusive:

Number of wells completed in Indiana, 1907–1911, by counties.

County.	Completed.					Dry.					Oil.				
	1907	1908	1909	1910	1911	1907	1908	1909	1910	1911	1907	1908	1909	1910	1911
Adams	32	15	14	13	2	3	2	3	1	1	29	13	11	12	1
Blackford	22	40	23	7	2	3	9	4	2	.....	19	31	19	5	2
Cass	.....	.....	3	.....	.....	.....	.....	2	.....	.....	.....	.....	1	.....	.....
Daviess	.....	.....	1	1	7	.....	.....	.....	.....	2	.....	.....	1	1	.....
Delaware	65	29	13	10	15	16	14	5	.....	5	49	15	8	9	10
Dubois	.....	.....	.....	5	.....	.....	.....	.....	4	.....	.....	.....	.....	1	.....
Gibson	21	10	8	9	1	4	3	6	7	1	17	7	2	2	.....
Grant	115	90	37	2	.....	12	7	2	1	.....	103	83	35	1	.....
Huntington	48	17	15	3	.....	2	2	3	.....	.....	46	15	12	3	.....
Jay	152	107	63	34	13	30	25	17	10	3	122	82	46	21	9
Knox	.....	.....	.....	4	7	.....	.....	.....	3	6	.....	.....	.....	1	1
Madison	5	2	1	.....	3	2	.....	.....	.....	3	3	2	1	.....	.....
Martin	.....	.....	.....	2	.....	.....	.....	.....	1	.....	.....	.....	.....	1	.....
Miami	.....	.....	1	.....	.....	.....	.....	1	.....	.....	.....	.....	.....	.....	.....
Pike	.....	.....	65	215	40	.....	.....	27	25	11	.....	.....	38	179	2
Pulaski	.....	.....	4	.....	.....	.....	.....	3	.....	.....	.....	.....	1	.....	.....
Randolph	3	5	5	20	4	1	1	1	7	.....	2	4	4	13	
Sullivan	.....	.....	.....	3	.....	.....	.....	.....	.....	.....	.....	.....	.....	3	.....
Vigo	.....	.....	2	1	.....	.....	.....	1	1	.....	.....	.....	1	.....	.....
Warrick	.....	.....	.....	3	1	.....	.....	.....	3	1	.....	.....	.....	.....	.....
Wells	122	70	39	33	17	2	4	.....	.....	.....	120	66	39	32	1
Miscellaneous	73	17	11	1	5	53	15	11	1	2	20	2	.....	.....	
Total	658	402	305	366	117	*a*128	*a* 82	*a* 86	*b* 66	*b* 35	530	320	219	284	7

a Including gas wells. *b* Not including gas wells.

Number of wells completed in Indiana, 1907–1911, by months.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1907	50	42	69	50	57	77	61	59	45	58	47	43	658
1908	35	23	31	21	29	35	35	39	47	38	33	36	402
1909	30	16	18	24	26	36	27	27	19	29	16	37	305
1910	18	33	29	27	25	38	38	41	35	26	36	20	366
1911	14	10	10	8	8	10	11	11	8	6	15	6	117

Number of dry holes drilled in Indiana, 1907–1911, by months.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1907	7	12	14	12	12	16	10	13	6	9	7	10	[a] 128
1908	12	9	7	5	7	7	7	7	1	6	5	9	[a] 82
1909	9	7	2	4	7	9	8	6	6	13	5	10	[a] 86
1910	3	4	3	5	4	2	4	6	7	5	16	7	[b] 66
1911	4	3	1	3	2	2	5	4	2	2	7	......	[b] 35

[a] Including gas wells.

[b] Not including gas wells.

Total and average initial daily production of new wells in Indiana, 1907–1911, by counties, in barrels.

County.	Total initial production.					Average initial production per well.				
	1907	1908	1909	1910	1911	1907	1908	1909	1910	1911
Adams	171	177	58	73	10	5.9	13.6	5.3	6.1	10.0
Blackford	140	264	140	75	5	7.4	8.5	7.4	15.0	2.5
Cass	......	......	2	......	......	......	......	2.0	......	......
Daviess	......	......	20	5	......	......	......	20.0	5.0	......
Delaware	715	312	142	232	325	14.6	20.8	17.8	25.8	32.5
Dubois	......	......	......	15	......	......	......	......	15.0	......
Gibson	304	75	35	20	......	17.9	10.7	17.5	10.0	......
Grant	770	749	167	1	......	7.5	9.0	4.8	1.0	......
Huntington	485	154	77	40	......	10.5	10.3	6.4	13.3	......
Jay	1,362	900	378	203	90	11.2	11.0	8.2	9.7	10.0
Knox	......	......	......	10	5	......	......	......	10.0	5.0
Madison	50	15	40	......	......	16.7	7.5	40.0	......	......
Martin	......	......	......	5	......	......	......	......	5.0	......
Miami	......	......	......	......	......	......	......	......	......	......
Pike	......	......	2,385	7,453	439	......	......	62.7	41.6	16.3
Pulaski	......	......	5	......	......	......	......	5.0	......	......
Randolph	25	35	130	207	26	12.5	8.8	32.5	15.9	6.5
Sullivan	......	......	......	25	......	......	......	......	8.3	......
Vigo	......	......	20	......	......	......	......	20.0	......	......
Warrick	......	......	......	......	......	......	......	......	......	......
Wells	1,067	537	264	300	181	8.9	8.1	6.8	9.4	10.6
Miscellaneous	308	40	......	......	15	15.4	20.0	......	......	5.0
Total	5,397	3,258	3,863	8,664	1,096	10.2	10.2	17.6	30.5	14.8

Total initial daily production of new wells in Indiana, 1907–1911, by months, in barrels.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1907	438	256	566	380	625	655	427	454	313	513	418	352	5,397
1908	258	135	225	144	262	335	201	322	563	301	241	271	3,258
1909	308	59	200	241	281	298	467	287	381	445	114	782	3,863
1910	488	885	820	714	746	1,745	676	1,159	400	480	290	261	8,664
1911	142	53	129	73	66	77	107	155	75	85	52	82	1,096

ILLINOIS OIL FIELD.

Oil and gas were discovered in Illinois in 1865 in a well drilled about 8 miles north of Casey in Clark County. About the same time oil and gas in small quantity were found at Litchfield, Montgomery County, and the oil was utilized for local lubricating purposes for many years. In 1900 wildcatting was started again in Robinson Township, Crawford County, and although the wells then drilled were failures, the attention called to the region led to the development of the main oil field, for a well was drilled in 1904 near Casey and small oil wells resulted at 400 to 600 feet. The field was extended in 1906 by D. T. Finley to Oblong Township in Crawford County. The developments extended rapidly to Lawrence County in 1907.

At present the main oil field of Illinois is a feature of the great La Salle anticline extending east of south near La Salle in the northeastern part of the State through Sadorous and St. Francisville and passing over into the southwestern part of Indiana through Princeton, in Pike County. The higher domes in this anticline are oil bearing in the Carboniferous (Pennsylvanian and Mississippian) in Clark, Cumberland, Crawford, and Lawrence counties. The oil is thick, asphaltic, and contains sulphur in the northern end and is found at shallow depths (400 to 700 feet), while to the south it is found deeper (over 2,200 feet in Lawrence County), and here it is thinner and contains little or no sulphur.

PRODUCTION AND DEVELOPMENT.

Other noteworthy occurrences of oil are at Sandoval and Centralia in Marion County, at Carlyle in Clinton County, and at Carlinville in Macoupin County. There are also interesting occurrences of oil and gas in Morgan County, where some light gas wells and one 5-barrel oil well were drilled about 6 miles west of Jacksonville. In Perry County the Midvalley Oil Co., of St. Louis, found a showing of oil in their prospect 4 miles east of Pinckneyville late in November. A conspicuous north-and-south anticline between Duquoin and Pinckneyville had been previously pointed out by the Geological Survey of Illinois.

The Geological Survey of Illinois has led to the development of some of these localities and suggests further search for oil and gas along the course of the La Salle anticline to the north, in the "Trenton" limestone. The corresponding formations in the southern portion of the State are considered less inviting because of faulting and of the difficulty of studying the structure, which is obscured by drift.

In the summer of 1911 E. W. Shaw, for the United States Geological Survey, made a detailed study of a large part of Clinton, Washington, and St. Clair counties in cooperation with the Geological Survey of Illinois, and discovered several districts in addition to that at Carlyle in which the structure of the rocks is such as to favor the accumulation of oil and gas, whereas the remainder of the territory probably contains nothing but salt water. In this investigation Mr. Shaw has laid stress on the following factors governing oil and gas accumulations: (1) Structure or lay of the rocks, (2) the presence and shape of a good reservoir or sand, and (3) the size and relative positions of bodies of salt water. A curious fact in connection with oil and gas accumulation is that because of a greater capillary attraction water can drive oil out of certain kinds of porous rocks. The places for oil accumulations are thus in the kinks and corners of porous rocks, where the oil is protected somewhat from the pressure of the water. Furthermore, since oil and gas are lighter than water, they commonly take a position in the uppermost part of a porous stratum where such a stratum is overlain by impervious material, such as clay. An intelligent search for oil bodies must therefore take into account all the items enumerated above.

In southern Illinois the sources of geologic information are chiefly rock exposures and well records, but to a small extent also the surface features. Although the layers of rock are nowhere exactly parallel and vary considerably in thickness, yet they are everywhere approximately parallel and the lay of the beds far below the surface can be inferred by working out, by means of rock outcrops and well records, the lay of beds at or near the surface. With regard to the character of the rocks far below the surface much can be learned by studying these rocks in areas where they outcrop at the surface. Information on salt-water bodies comes almost entirely from deep wells, and hence is lacking until such wells are sunk.

By the methods suggested in the preceding paragraphs the following places have been selected as worthy of being tested for oil and gas:

The vicinity of Darmstadt, northeast of Lenzburg.
About Marissa and extending for several miles toward Oakdale.
Between Nashville and Addieville.
The vicinity of Hoffman.
Between Mascoutah and Okawville.
Between Trenton and Breese.
In a belt extending from a few miles north to a few miles south of O'Fallon.
The central part of Irishtown Township northeast of Carlyle.
One to three miles northeast of Bartelso.

A more exact statement of positions and limits of the likely districts must await further study. It is not to be assumed that all of these districts mentioned contain pools of oil or gas but only that conditions seem to be much more favorable than in surrounding territory.

The oil and gas pools of Illinois have all been found in districts where the geology is similar to that of the districts enumerated above, but there are probably many such districts where no oil and gas exist. From these facts it would appear likely that if any oil is found outside the districts mentioned above, it will be where there are similar conditions but where the geology is so obscure that they have not yet been discovered.

The preliminary bulletin of Raymond S. Blatchley, geologist of the Geological Survey of Illinois, gives the following information concerning oil developments in Illinois in 1911:

THE SOUTHERN ILLINOIS OIL FIELDS.

Clark County.—The Clark County and adjoining shallow-oil areas have shown little development. There was a continued decrease in production from 1910. The combined daily output of the Clark, Cumberland, and Edgar County wells was about 8,000 barrels, as against 9,000 barrels in 1910.

Crawford County.—Crawford County showed the first evidence of a rapid decline in 1910. No new additions to the field were developed and inside drilling failed to prevent decrease of production in 1911. The average daily output was about 18,000 barrels, as against 30,000 barrels in 1910 and 100,000 barrels in 1907.

Lawrence County.—Lawrence County is the richest producing area in the State. There are seven sands from 750 to 1,900 feet deep, that yield steadily. In order they are: The Bridgeport Nos. 1, 2, and 3 lenses, 750 to 1,000 feet; the Buchanan, 1,100 to 1,400 feet; the Kirkwood, 1,350 to 1,650 feet; the Tracey, 1,550 to 1,750 feet; and the McClosky, 1,750 to 1,900 feet. The Kirkwood and McClosky sands, especially the latter, are the richest developed in Illinois. Their accumulation of oil and gas is governed by a long double-plunging anticline. Lawrence County maintained its usual production of about 42,000 barrels without new additions to the field. Both "sour" and "sweet" oils were produced and handled separately.

SOUTHERN-CENTRAL AND WESTERN ILLINOIS.

Marion County.—The Sandoval field of Marion County in 1911 was clearly defined and found limited to about three-fourths of a square mile. There are about 66 producing wells that have a daily yield of 1,800 barrels. The oil comes from the Stein and Benoist sands, which occur in the basal portion of the Chester rocks of the Mississippian formations and are equivalent to the Kirkwood sand of Lawrence County. The Sandoval field lies along an irregular structural terrace upon the broad and gentle western flank of the Illinois basin.

Clinton County.—The best new field for the year east of the Mississippi was opened 3 miles northwest of Carlyle in April. The area was described and recommended by the State Geological Survey previous to the discovery. The oil comes from a sand in the bottom part of the Chester rocks and is considered the equivalent of the Benoist sand of Sandoval and the Kirkwood sand of Lawrence County. The field is governed by an elongated dome on the western flank of the Illinois basin and has an areal extent of about 1½ square miles. The gravity of the oil is about 35° B. There are about 120 wells yielding about 4,500 barrels daily.

The production of the first Carlyle wells was about 200 barrels. This caused great excitement in the oil trade, with the result that enormous bonuses were paid for leases many miles from producing territory. The field proved to be very limited and a great amount of money was lost.

Oil and considerable gas were found late in the year near Carlinville, Macoupin County, but the region was not sufficiently exploited to establish the value of the field.

Oil and gas have been noted at many other isolated points in Illinois. They are described in detail in the publications of the Illinois Geological Survey, especially in Bulletin 16.

In the Illinois fields over 20,000 wells have been drilled within the short period of the present development (since 1904), and 4 out of every 5 have yielded oil. The wells have been remarkable for their persistence as producers, so that, although not so many new wells were drilled in 1911, and the product declined somewhat, the year was nevertheless a very satisfactory one on account of better prices.

Production of petroleum in Illinois, 1906–1911, by months, in barrels.

Month.	1906	1907	1908	1909	1910	1911
January	55,680	781,812	2,703,973	2,668,607	2,640,303	2,578,579
February	65,208	956,399	2,572,115	2,510,548	2,353,684	2,373,229
March	19,352	1,547,323	2,825,491	2,757,794	2,865,055	2,790,515
April	102,862	1,874,465	3,249,690	2,562,215	2,776,800	2,560,963
May	267,746	2,138,918	3,223,515	2,829,277	2,860,760	2,731,965
June	410,655	1,879,362	3,081,848	2,670,549	2,746,620	2,634,521
July	610,401	2,422,192	2,693,288	2,728,857	3,029,787	2,740,654
August	778,464	2,446,042	2,808,667	2,719,958	3,007,151	2,770,946
September	722,168	2,605,663	2,675,385	1,902,197	2,850,119	2,615,120
October	463,819	2,863,812	2,709,913	2,560,072	2,768,750	2,638,927
November	350,985	2,510,146	2,479,926	2,497,847	2,629,132	2,400,670
December	549,710	2,255,839	2,662,427	2,490,418	2,615,201	2,480,949
Total	4,397,050	24,281,973	33,686,238	30,898,339	33,143,362	31,317,038

Production and value of petroleum in Illinois, 1906–1911, in barrels.

Year.	Ohio Oil Co.	Other lines.	Total quantity.	Total value.
1906	4,385,471	11,579	4,397,050	$3,274,818
1907	23,733,790	548,183	24,281,973	16,432,947
1908	31,972,634	1,713,604	33,686,238	22,649,561
1909	27,640,773	3,257,566	30,898,339	19,788,864
1910	27,751,090	5,392,272	33,143,362	19,669,383
1911	25,987,480	5,329,558	31,317,038	19,734,339

Production of petroleum in Illinois in 1910 and 1911, by kinds, in barrels.

Year.	Light.	Heavy.	Total.
1910	30,444,279	2,699,083	33,143,362
1911	29,103,220	2,213,818	31,317,038

PIPE-LINE RUNS, DELIVERIES, AND STOCKS.

The following tables show the runs of the Ohio Oil Co. during the years 1906–1911, and deliveries and stocks in 1908–1911, by months:

Pipe-line runs, deliveries, and stocks of the Ohio Oil Co. in Illinois, 1906–1911, by months, in barrels.

Month.	Pipe-line runs.					
	1906	1907	1908	1909	1910	1911
January	55,680	752,671	2,497,359	2,494,492	2,220,842	2,137,674
February	65,208	918,620	2,464,914	2,358,198	1,976,637	1,968,429
March	19,352	1,494,598	2,591,911	2,568,392	2,377,012	2,349,208
April	102,862	1,823,025	3,089,417	2,388,309	2,306,336	2,138,500
May	267,746	2,094,195	3,084,816	2,536,413	2,374,134	2,264,925
June	410,655	1,830,634	2,965,786	2,365,956	2,274,501	2,177,280
July	610,401	2,376,281	2,579,977	2,413,218	2,569,830	2,265,374
August	778,464	2,398,895	2,690,931	2,411,483	2,528,532	2,312,973
September	722,168	2,560,593	2,555,871	1,595,934	2,409,232	2,154,693
October	463,819	2,818,032	2,582,561	2,228,269	2,334,659	2,172,457
November	350,985	2,464,981	2,356,386	2,149,372	2,211,286	1,977,073
December	538,131	2,201,265	2,512,705	2,130,737	2,168,089	2,068,894
Total	4,385,471	23,733,790	31,972,634	27,640,773	27,751,090	25,987,480

Month.	Deliveries.			
	1908	1909	1910	1911
January	1,720,631	324,887	1,226,379	933,861
February	1,882,978	869,212	842,135	838,566
March	1,010,459	721,519	882,209	1,218,111
April	1,476,192	891,423	936,706	1,022,936
May	1,869,461	903,838	946,346	1,132,231
June	1,846,947	1,077,383	1,156,895	1,174,211
July	2,012,288	1,176,410	1,332,242	1,231,534
August	1,774,354	1,052,431	1,229,479	1,206,244
September	1,488,283	849,533	1,135,323	1,252,988
October	1,394,983	938,860	1,245,778	1,352,605
November	1,284,304	1,120,751	997,805	1,304,663
December	1,789,158	685,585	1,036,260	1,454,394
Total	19,550,038	10,611,832	12,967,557	14,122,344

Pipe-line runs, deliveries, and stocks of the Ohio Oil Co. in Illinois, 1906–1911, by months, in barrels—Continued.

Month.	Stocks.			
	1908	1909	1910 [a]	1911 [a]
January	14,129,954	25,876,529	28,355,182	26,252,274
February	15,069,278	26,203,238	28,356,243	25,643,012
March	15,975,633	26,630,509	28,373,855	24,005,215
April	17,420,534	26,856,675	28,593,365	24,013,861
May	19,077,020	27,593,494	29,025,647	24,138,187
June	20,456,387	27,899,220	29,106,098	23,195,749
July	21,036,143	27,627,086	29,198,965	22,714,129
August	22,267,197	27,683,334	29,177,382	22,265,928
September	23,485,690	28,399,427	28,879,676	21,904,719
October	24,396,787	28,535,636	28,492,136	21,359,482
November	24,905,168	28,373,985	28,086,619	20,211,934
December	25,252,468	28,671,543	27,348,358	19,131,678

[a] Includes some Indiana petroleum.

The following table shows the quantity of petroleum shipped by railroad from the Illinois oil field, 1908 to 1911, by months:

Shipments of petroleum by railroad in tank cars from Illinois oil field, in pounds and equivalent in barrels, 1908–1911, by months.

Month.	1908 [a]		1909 [b]		1910 [c]		1911 [d]	
	Pounds.	Barrels.	Pounds.	Barrels.	Pounds.	Barrels.	Pounds.	Barrels.
January	27,369,575	91,807	42,962,321	144,511	65,642,102	220,856	67,817,700	228,404
February	21,191,859	71,170	33,135,044	111,407	64,727,081	217,917	66,787,506	224,856
March	39,352,395	132,300	45,220,034	152,056	78,297,914	263,056	75,823,670	254,927
April	35,198,236	118,074	32,756,603	109,872	76,629,857	257,292	103,492,508	347,530
May	25,177,339	84,290	46,914,958	157,783	84,174,328	283,285	99,184,423	333,324
June	36,566,990	122,317	54,585,149	183,432	84,794,030	285,095	98,233,351	329,621
July	32,087,310	107,688	47,158,942	158,642	82,242,109	276,533	92,667,599	311,681
August	20,912,433	70,171	49,602,064	166,943	82,505,800	277,317	88,408,923	297,784
September	24,771,903	83,042	51,574,673	173,509	75,462,070	253,788	70,923,322	238,917
October	30,427,564	102,163	59,425,540	200,067	63,301,200	213,217	86,688,528	292,004
November	41,096,712	138,147	58,881,214	198,044	85,453,500	287,750	78,250,470	263,627
December	37,751,352	126,967	55,130,392	185,166	69,768,400	234,819	84,607,440	285,082
Total	371,903,668	[e]1,248,136	577,346,934	[e]1,941,432	912,998,391	[e]3,070,925	1,012,885,440	[e]3,407,757

[a] Shipments were made from Duncansville, Lawrenceville, Stoy, Robinson, Bridgeport, Sparta, and Casey. The railroads which shipped crude petroleum from Illinois were the Vandalia, the Baltimore & Ohio, the Illinois Southern, the Indianapolis Southern, and the Cleveland, Cincinnati, Chicago & St. Louis.

[b] Shipments were made from Duncansville, Flat Rock, Lawrenceville, Stoy, Robinson, Bridgeport, Casey, and Sparta, the same railroads shipping in 1909 as in 1908. The number of tank cars shipped in 1909 was 11,820.

[c] Shipments were made from Duncansville, Flat Rock, Lawrenceville, Stoy, Sandoval, Bridgeport, Casey, and Sparta, the same railroads shipping in 1910 as in 1908 and 1909. The number of tank cars shipped in 1910 was 17,049.

[d] Shipments were made from Duncansville, Lawrenceville, Flat Rock, Stoy, Bridgeport, Sandoval, Casey, and Sparta, the same railroads shipping in 1911 as in 1910. The number of tank cars shipped in 1911 was 19,619.

[e] Calculations made according to specific gravity of the oil, ranging from 296.476 to 321.17 pounds to the barrel.

PRICES.

In the following table are given the dates of change and the changes in prices at wells of the different grades of petroleum produced in Illinois during the years 1909, 1910, and 1911:

Fluctuation in prices, per barrel, of Illinois petroleum in 1909, 1910, and 1911.

1909			1910			1911		
Date.	Above 30° B.	Below 30° B.	Date.	Above 30° B.	Below 30° B.	Date.	Above 30° B.	Below 30° B.
Jan. 1	$0.68	$0.60	Jan. 1	$0.60	$0.52	Jan. 1	$0.60	$0.52
June 26	.65	.57				May 2	.63	.55
July 16	.62	.54				June 14	.65	.55
Oct. 21	.60	.52				Sept. 15	.67	.55
						Sept. 19	.67	.57

In the following table are given the average monthly prices paid for Illinois petroleum at wells in Illinois from 1907 to 1911, inclusive:

Average monthly prices of Illinois petroleum, 1907–1911, per barrel.

Month.	1907	1908		1909		1910		1911	
		Above 30° B.	Below 30° B.	Above 30° B.	Below 30° B.	Above 30° B.	Below 30° B.	Above 30° B.	Below 30° B.
January	$0.64	$0.68	$0.60	$0.68	$0.60	$0.60	$0.52	$0.60	$0.52
February	.65¼	.68	.60	.68	.60	.60	.52	.60	.52
March	.67½	.68	.60	.68	.60	.60	.52	.60	.52
April	.68	.68	.60	.68	.60	.60	.52	.60	.52
May	.68	.68	.60	.68	.60	.60	.52	.63	.55
June	.68	.68	.60	.67½	.59½	.60	.52	.64	.55
July	.68	.68	.60	.63⅜	.55⅜	.60	.52	.65	.55
August	.68	.68	.60	.62	.54	.60	.52	.65	.55
September	.68	.68	.60	.62	.54	.60	.52	.66	.56
October	.68	.68	.60	.61¼	.53¼	.60	.52	.67	.57
November	.68	.68	.60	.60	.52	.60	.52	.67	.57
December	.68	.68	.60	.60	.52	.60	.52	.67	.57
Average	.67⅜	.68	.60	.64⅝	.56⅝	.60	.52	.637	.546

WELL RECORD.

In the following tables is given the well record for Illinois from 1907 to 1911, inclusive:

Number of wells completed in Illinois, 1907–1911, by counties.

County.	Completed.					Dry.					Oil.				
	1907	1908	1909	1910	1911	1907	1908	1909	1910	1911	1907	1908	1909	1910	1911
Bond	.....	.....	.....	7	10	.....	.....	.....	5	9	.....	.....	.....	1	.....
Clark	1,176	385	181	112	72	201	87	47	28	25	975	298	134	80	45
Clinton	.....	.....	.....	3	172	.....	.....	.....	3	49	.....	.....	.....	.....	123
Coles	56	9	12	5	2	11	1	3	1	.....	45	8	9	4	2
Crawford	2,840	2,322	2,093	1,210	481	376	336	355	214	93	2,464	1,986	1,738	950	369
Cumberland	152	42	33	17	13	13	11	10	2	7	139	31	23	13	6
Edgar	25	9	6	2	1	14	2	4	1	1	11	7	2	.....	.....
Hancock	.....	.....	.....	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	1	.....
Jackson	.....	.....	3	2	.....	.....	.....	2	2	.....	.....	.....	1	.....	.....
Jasper	.....	.....	18	8	5	.....	.....	11	4	2	.....	.....	7	4	3
Lawrence	691	762	724	689	523	70	78	56	79	38	621	684	668	594	466
Macoupin	.....	.....	9	2	2	.....	.....	8	2	.....	.....	.....	1	.....	2
Madison	.....	.....	2	1	1	.....	.....	1	1	1	.....	.....	1	.....	.....
Marion	.....	.....	23	60	55	.....	.....	17	26	11	.....	.....	6	34	44
Randolph	.....	.....	12	.....	.....	.....	.....	10	.....	.....	.....	.....	2	.....	.....
Saline	.....	.....	2	1	.....	.....	.....	1	1	.....	.....	.....	1	.....	.....
Miscellaneous	48	45	33	29	28	43	40	33	24	27	5	5	.....	.....	1
Total	4,988	3,574	3,151	2,149	1,365	[a]728	[a]555	[a]558	[b]393	263	4,260	3,019	2,593	1,681	1,061

[a] Including gas wells.

[b] Not including gas wells.

Number of wells completed in Illinois, 1907–1911, by months.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1907	253	356	351	387	493	639	521	461	400	363	430	334	4,988
1908	303	157	187	197	264	390	474	417	344	290	273	278	3,574
1909	213	224	216	263	321	342	346	303	282	242	223	176	3,151
1910	111	158	128	157	192	211	172	245	234	198	177	166	2,149
1911	105	89	70	81	117	147	127	150	135	107	129	108	1,365

Number of dry holes drilled in Illinois, 1907–1911, by months.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1907	41	55	60	40	64	75	72	45	62	82	80	52	[a] 728
1908	55	22	37	33	35	54	65	55	49	51	47	52	[a] 555
1909	41	47	45	38	45	53	50	57	50	48	52	32	[a] 558
1910	9	36	24	31	35	44	37	40	42	29	36	30	[b] 393
1911	16	16	10	13	31	37	24	25	34	16	23	18	[b] 263

[a] Including gas wells.

[b] Not including gas wells.

Total and average initial daily production of new wells in Illinois, 1907–1911, by counties, in barrels.

County.	Total initial production.					Average initial production per well.				
	1907	1908	1909	1910	1911	1907	1908	1909	1910	1911
Bond	....	....	....	25	....	....	....	....	25.0	....
Clark	20,385	6,953	3,219	1,802	771	20.9	23.3	24.0	22.5	17.1
Clinton	....	....	....	....	11,681	....	....	....	....	95.0
Coles	314	122	95	65	10	7.0	15.3	10.6	16.3	5.0
Crawford	84,163	46,694	44,379	26,382	9,802	34.2	23.5	25.5	27.8	26.6
Cumberland	3,612	303	558	162	100	26.0	9.8	24.3	12.5	16.7
Edgar	118	45	10	....	....	10.7	6.4	5.0	....	....
Hancock	....	....	....	5	....	....	....	....	5.0	....
Jackson	....	....	3	....	....	....	....	3.0	....	....
Jasper	....	....	50	40	20	....	....	7.1	10.0	6.7
Lawrence	30,543	24,793	41,056	61,015	40,432	49.2	36.2	61.5	102.7	86.8
Macoupin	....	....	5	....	7	....	....	5.0	....	3.5
Madison	....	....	10	....	....	....	....	10.0	....	....
Marion	....	....	223	3,760	4,025	....	....	37.2	110.6	91.5
Randolph	....	....	145	....	....	....	....	72.5	....	....
Saline	....	....	3	....	....	....	....	3.0	....	....
Miscellaneous	28	50	....	....	3	5.6	10.0	....	....	3.0
Total	139,163	78,960	89,756	93,256	66,851	32.7	26.2	34.6	55.5	63.0

Total initial daily production of new wells in Illinois, 1907–1911, by months, in barrels.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1907	9,433	9,842	10,392	11,083	13,329	18,807	17,375	11,240	10,967	8,157	9,780	8,758	139,163
1908	6,144	3,329	4,133	4,285	6,628	9,856	9,475	8,322	7,848	6,091	6,242	6,607	78,960
1909	5,060	4,833	5,018	5,237	7,681	9,050	9,820	8,661	8,324	8,904	9,628	7,540	89,756
1910	5,331	6,840	5,593	7,260	8,091	9,267	6,386	10,042	8,419	10,133	8,832	7,062	93,256
1911	5,677	3,512	3,909	5,587	5,132	5,850	9,058	7,535	6,551	4,782	5,826	3,432	66,851

MID-CONTINENT OIL FIELD.

PRODUCTION.

It has been customary to group the production of Kansas, Oklahoma, north Texas, and north Louisiana (Caddo field) as the Mid-Continent field, inasmuch as the products are very similar, and quite different from the products of the Gulf field to the south. Every member of the group increased in the quantity of petroleum product and in its value. In Oklahoma and the Caddo field this increase was sufficient to raise the total product from 58,965,865 barrels in 1910 to 65,917,788 barrels in 1911, or almost 7,000,000 barrels; while the total value of the crude oil at the wells advanced from $23,060,834 in 1910 to $31,563,141 in 1911. This is the greatest production ever yielded by the region and is almost three times the quantity produced in 1906. Increased pipe-line facilities and better prices for the crude are stimulating drilling all over the region.

Production and value of petroleum in the Mid-Continent field, 1906–1911, by States, in barrels.

Year.	Kansas and Oklahoma.		Northern Texas.		Caddo, La.		Total.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
1906	21,718,648	$9,615,198	1,117,905	$740,542	3,358	$2,183	22,839,911	$10,357,923
1907	45,933,649	18,478,658	912,618	721,577	50,000	38,850	46,896,267	19,239,085
1908	47,600,546	18,441,538	723,264	479,072	499,937	214,048	48,823,747	19,134,658
1909	49,122,982	17,920,623	681,940	393,732	1,028,818	549,081	50,833,740	18,863,436
1910	53,157,386	20,367,423	717,686	402,554	5,090,793	2,290,857	58,965,865	23,060,834
1911	57,348,456	27,060,523	1,573,504	848,893	6,995,828	3,653,725	65,917,788	31,563,141

Production of petroleum in the Mid-Continent field in 1910 and 1911, by months, in barrels.

Month.	1910					1911				
	Kansas.	Oklahoma.	Northern Texas.	Caddo, La.	Total.	Kansas.	Oklahoma.	Northern Texas.	Caddo, La.	Total.
Jan	91,908	4,281,251	61,950	121,629	4,556,738	90,735	4,257,613	62,361	437,546	4,848,255
Feb	80,899	3,738,386	58,581	150,674	4,028,540	88,894	4,124,124	55,801	348,683	4,617,502
Mar	95,405	4,786,204	66,915	212,770	5,161,294	107,551	6,364,165	60,129	475,387	7,007,232
Apr	89,461	5,149,595	61,961	262,211	5,563,228	96,325	5,293,826	59,946	430,159	5,880,256
May	96,637	4,554,471	60,399	406,058	5,117,565	101,632	4,938,354	64,529	574,203	5,678,718
June	97,773	4,502,190	60,691	587,523	5,248,177	103,967	4,679,055	64,265	677,403	5,524,690
July	90,581	4,419,814	56,734	481,344	5,048,473	98,464	4,551,829	69,153	711,012	5,430,458
Aug	98,898	4,308,760	60,521	354,355	4,822,534	112,951	4,503,521	118,973	599,157	5,334,602
Sept	94,859	4,147,597	56,355	771,744	5,070,555	113,553	4,418,832	155,975	731,306	5,419,666
Oct	97,888	4,153,469	56,963	764,123	5,072,443	119,705	4,473,220	253,155	791,868	5,637,948
Nov	92,133	3,955,600	54,960	501,866	4,604,559	131,188	4,222,738	310,436	652,675	5,317,037
Dec	102,226	4,031,381	61,656	476,496	4,671,759	113,854	4,242,360	298,781	566,429	5,221,424
Total	1,128,668	52,028,718	717,686	5,090,793	58,965,865	1,278,819	56,069,637	1,573,504	6,995,828	65,917,788

In the following table is shown the production and increase and decrease, with percentages, of petroleum in the Mid-Continent field since 1889:

Production and increase and decrease, with percentages, of petroleum in the Mid-Continent oil field, 1889–1911, by States, in barrels.

Year.	Kansas.	Oklahoma.	Northern Texas.[a]	Caddo, La.	Total.	Percentage of total production.	Increase.	Percentage of increase.
1889	500				500			
1890	1,200				1,200		700	140.00
1891	1,400	30			1,430		230	19.17
1892	5,000	80			5,080		3,650	255.24
1893	18,000	10			18,010	0.04	12,930	254.53
1894	40,000	130			40,130	.08	22,120	122.82
1895	44,430	37			44,467	.08	4,337	10.81
1896	113,571	170	1,400		115,141	.19	70,674	158.93
1897	81,098	625	65,925		147,648	.24	32,507	28.23
1898	71,980		544,620		616,600	1.11	468,952	317.62
1899	69,700		668,483		738,183	1.29	121,583	19.72
1900	74,714	6,472	[b]836,039		917,225	1.44	179,042	24.25
1901	179,151	10,000	[b]800,545		989,696	1.43	72,471	7.90
1902	331,749	37,100	617,871		986,720	1.12	[c]2,976	[c].30
1903	932,214	138,911	501,960		1,573,085	1.57	586,365	59.42
1904	4,250,779	1,366,748	569,102		6,186,629	5.28	4,613,544	293.28
1905	[d]12,013,495	(e)	520,282		12,533,777	9.30	6,347,148	102.60
1906	[d]21,718,648	(e)	1,117,905	3,358	22,839,911	18.05	10,306,136	82.23
1907	2,409,521	43,524,128	912,618	50,000	46,896,267	28.23	24,056,356	105.33
1908	1,801,781	45,798,765	723,264	499,937	48,823,747	27.35	1,927,480	4.11
1909	1,263,764	47,859,218	681,940	1,028,818	50,833,740	27.75	2,009,993	4.12
1910	1,128,668	52,028,718	717,686	5,090,793	58,965,865	28.14	8,132,125	16.00
1911	1,278,819	56,069,637	1,573,504	6,995,828	65,917,788	29.90	6,951,923	11.79

[a] Includes counties of Navarro, Jack, McLennan, and Marion.
[b] Includes a small production in southern Texas.
[c] Decrease.
[d] Includes the production of Oklahoma.
[e] Included in the production of Kansas.

PRICES.

In the following tables are given the prices paid by the Prairie Oil & Gas Co. for petroleum of different grades in Kansas and Oklahoma during 1907 to 1911, also the average monthly price during the years 1908 to 1911:

Range of prices paid per barrel for petroleum by the Prairie Oil & Gas Co. in Kansas and Oklahoma, 1907 to 1911.

Date.	32° B. and above.	31½° to 32° B.	31° to 31½° B.	30½° to 31° B.	30° to 30½° B.	Heavy.
1907.						
Jan. 1	$0.39	$0.36	$0.33	$0.30	$0.27	$0.26
Feb. 11	.40	.37	.34	.31	.28	.27
Mar. 9	.41	.38	.35	.32	.29	.28
1908.						
Jan. 1	.41	.38	.35	.32	.29	.28
1909.						
Jan. 1	$0.41					.28
June 30	.38					.28
July 22	.35					.23

Date.	Above 30° B.	Below 30° B.
1910.		
Jan. 1	$0.35	$0.28
Mar. 17	.38	.30
Sept. 2	.40	.30
Sept. 20	.40	.40
Nov. 14	.42	.42
	All grades.	
1911.		
Jan. 2	$0.44	
May 2	.46	
June 14	.48	
Sept. 15	.50	

Average monthly price of Kansas and Oklahoma petroleum, per barrel of 42 gallons, 1908–1911, by months.

Month.	1908				1909		1910		1911
	Kansas.		Oklahoma.		Above 30° B.	Below 30° B.	Above 30° B.	Below 30° B.	All grades.
	Light.	Heavy.	Light.	Heavy.					
January	$0.41	$0.308	$0.41	$0.325	$0.41	$0.28	$0.35	$0.28	$0.44
February	.41	.306	.41	.324	.41	.28	.35	.28	.44
March	.41	.297	.41	.326	.41	.28	.36⅜	.29	.44
April	.41	.302	.41	.321	.41	.28	.38	.30	.44
May	.41	.308	.41	.320	.41	.28	.38	.30	.46
June	.41	.297	.41	.320	.41	.28	.38	.30	.48
July	.41	.307	.41	.317	.37	.28	.38	.30	.48
August	.41	.312	.41	.322	.35	.28	.38	.30	.48
September	.41	.300	.41	.322	.35	.28	.40	.34¼	.50
October	.41	.310	.41	.326	.35	.28	.40	.40	.50
November	.41	.303	.41	.326	.35	.28	.41⅛	.41⅛	.50
December	.41	.302	.41	.312	.35	.28	.42	.42	.50
Average	.41	.304	.41	.322	.38⅛	.28	.38¼	.32¾	.45½

KANSAS.

Production.—The decline in oil production in Kansas during the last few years was checked in 1911 by better prices, which stimulated drilling in Allen, Chautauqua, Montgomery, and Neosho counties. For the first time in several years a slight increase in output was recorded, from 1,128,668 barrels in 1910, valued at $444,763, to 1,278,819 barrels in 1911, valued at $608,756, the increase in value being even more considerable than the increase in quantity. During the year the price of heavy oil in Kansas was raised to that of light oil and thenceforward shared the increase in price. The oil wells drilled numbered 172 against 85 in 1910; but the dry holes increased only slightly.

Production of petroleum in Kansas, 1908–1911, in barrels.

	1908	1909	1910	1911
Quantity piped from wells in Kansas to refineries	492,966	466,298	388,013	307,750
Rail shipments in Kansas	149,056	52,261	21,590	28,122
Estimated quantity piped from other wells in Kansas and sold	1,159,759	745,205	719,065	942,947
Total sales in Kansas	1,801,781	1,263,764	1,128,668	1,278,819
Total value	$746.695	$491,633	$444,763	$608,756

Well record.—The following tables give the well record for Kansas from 1907 to 1911, inclusive:

Number of wells completed in Kansas, 1907–1911, by counties.

County.	Completed.[a]					Oil.					Dry.				
	1907	1908	1909	1910	1911	1907	1908	1909	1910	1911	1907	1908	1909	1910	1911
Allen	45	192	151	78	59	6	22	16	13	30	2	37	35	14	10
Anderson		9	1												
Chautauqua	47	24	31	60	82	20	16	23	42	64	10	3	3	14	11
Elk			9	1	4			7							4
Franklin	16	2	7	3		9	1		1		6	1	1		
Labette			11	3	1				1				3		
Miami	10	6				5					2				
Montgomery	56	97	127	79	118	21	1	5	16	60	4	17	22	7	22
Neosho	112	118	100	87	59	7	30	18	9	16	18	34	17	17	22
Wilson	57	87	113	108	94				1	2	10	21	24	27	27
Woodson			2												
Miscellaneous	25	31	6	9	1		2		2		12	14	1	3	
Total	368	566	558	428	418	68	72	69	85	172	64	127	106	82	96

[a] Including gas wells.

Number of wells completed in Kansas, 1907–1911, by months.[a]

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1907	37	18	40	24	14	22	24	35	34	32	35	53	368
1908	37	45	48	32	47	59	45	31	53	62	54	53	566
1909	54	38	13	39	45	49	36	36	39	55	58	46	558
1910	45	48	42	40	34	29	36	25	30	47	28	24	428
1911	29	20	36	27	43	53	41	23	41	40	26	39	418

[a] Including gas wells.

Number of dry holes drilled in Kansas, 1907–1911, by months.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1907	10	3	4	5	3	4	2	6	4	8	7	8	64
1908	16	7	9	5	8	19	7	5	14	17	8	12	127
1909	14	8	11	7	6	8	9	7	6	13	12	5	106
1910	9	8	12	10	7	4	5	2	7	9	5	4	82
1911	8	5	7	7	10	10	9	9	2	7	15	7	96

Total and average initial daily production of new wells in Kansas, 1907–1911, by counties, in barrels.

County.	Total initial production.					Average initial production per well.				
	1907	1908	1909	1910	1911	1907	1908	1909	1910	1911
Allen	89	365	251	210	353	14.8	16.6	15.7	16.2	11.8
Bourbon										
Chautauqua	358	305	475	1,100	1,355	17.9	19.1	20.7	26.2	21.2
Elk			110					15.7		
Franklin	95	8		5		10.6	8.0		5.0	
Labette				20					20.0	
Miami	41					8.2				
Montgomery	213	15	113	382	1,300	10.1	15.0	22.6	23.9	21.7
Neosho	90	446	360	130	208	12.9	14.9	20.0	14.4	13.0
Wilson				10	55				10.0	27.5
Miscellaneous		20		40			10.0		20.0	
Total	886	1,159	1,309	1,897	3,271	13.0	16.1	19.0	22.3	19.0

Total initial daily production of new wells in Kansas, 1907–1911, by months, in barrels.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1907	73	60	127	80	88	50	35	40	85	75	73	100	886
1908	65	100	40	85	105	120	170	138	55	80	96	105	1,159
1909	50	45	225	166	220	130	98	55	85	65	70	100	1,309
1910	......	95	65	95	170	40	235	200	257	305	210	225	1,897
1911	155	90	304	161	438	255	285	363	265	380	265	310	3,271

OKLAHOMA.

General conditions.—Although petroleum and natural gas have been known in Oklahoma for many years, the real development of the region took on important proportions in 1903. Since that time 23,000 wells have been drilled for oil or gas and nearly 90 per cent have been successful. This work has developed a series of pools extending from near the Kansas line south to Okmulgee County and from the eastern portion of Osage County east to the shallow sands in Cherokee County and covering parts of Osage, Washington, Nowata, Tulsa, Rogers, Delaware, Pawnee, Creek, Wagoner, Cherokee, Okmulgee, and Muskogee counties. Outside of this large area, gas has been found to the east in Sequoyah County near Poteau. Oil has been found as far south as Madill, in Marshall County, and to the southwest near Lawton in Comanche County. Inviting discoveries have also been made in Okfuskee County, and one of the interesting features of 1911 was the development of a pool in Kay County, to the west of Osage County.

The discovery of the Glenn pool in Creek County in 1907 led to such great development that the stocks of oil in the hands of the pipe-line companies in Oklahoma and Kansas rose to 50,000,000 barrels in 1910. This excessive production kept the price at figures which were abnormally low from the point of view of the character of the oils and the cost of transportation to market. Therefore, when in 1911 production from the older wells began to decline faster than the addition from new wells, and stocks began to recede, prices rose rapidly.

Production.—As shown by the tables which follow, the production of oil in Oklahoma increased to 56,069,637 barrels in 1911. The most significant factor in this increase was the development of the Barnsdall and Sinclair pools in the neighborhood of Osage Junction, Osage County, where wells of 1,000 to 3,000 barrels daily yield were brought in with sufficient frequency during the year to keep the production of the pool in the neighborhood of 20,000 barrels a day with the usual gradual decline. Although pressures in the new pools decreased toward the end of the year, this new production together with the increase in the Hogshooter pool and in the Pawnee County pools pushed the output beyond the record production of 1910, and in spite of the great drought in June and July. This drought was so severe as to drain even the drinking supply of several towns, and it interfered greatly not only with drilling but with manufacturing enterprises. Several times during the year stocks were drawn upon to a slight extent and each time an increase in the price of the oil resulted. Transportation facilities from the new pools were increased by an 8-inch line built by the Prairie Oil & Gas Co., from Turley west to Osage Junction. Another 8-inch line was built by the same company from Osage Junction to Cherokee, 30 miles to the northeast. The Texas and Gulf companies also ran lines connecting the Osage pools.

The following table shows the production and sales of petroleum in Oklahoma from 1908 to 1911:

Production of petroleum in Oklahoma, 1908–1911, in barrels.

	1908	1909	1910	1911
Estimated quantity shipped from Glenn pool and sold	20,494,313	18,946,740	19,236,914	13,880,118
Estimated quantity piped from other wells in Oklahoma and sold	25,012,423	28,330,313	32,124,072	41,783,947
Rail shipments (outside Glenn pool) in Oklahoma	292,029	582,165	667,732	405,572
Total sales in Oklahoma	45,798,765	47,859,218	52,028,718	56,069,637
Total value	$17,694,843	$17,428,990	$19,922,660	$26,451,767

Production of petroleum in Oklahoma in 1910 and 1911, by months, in barrels.

1910

Month.	Runs from wells.		Shipped by rail and fuel consumption not included in pipe-line runs.	Total.
	Gulf, Prairie, and Texas companies' pipe lines.	Alluwe, Chelsea, Cherokee, Muskogee, National Refining, Nowata, and other lines to refineries.		
January	3,773,499	316,315	191,437	4,281,251
February	3,237,303	323,750	177,333	3,738,386
March	4,071,046	364,657	350,501	4,786,204
April	4,486,871	367,721	295,003	5,149,595
May	3,907,563	389,096	257,812	4,554,471
June	4,031,123	386,606	84,461	4,502,190
July	3,964,964	394,162	60,688	4,419,814
August	3,817,891	418,307	72,562	4,308,760
September	3,698,588	409,494	39,515	4,147,597
October	3,705,210	406,962	41,297	4,153,469
November	3,498,567	422,622	34,411	3,955,600
December	3,518,126	477,358	35,897	4,031,381
Total	45,710,751	[a] 4,677,050	1,640,917	52,028,718

1911

Month.	Gulf, Prairie, and Texas companies' pipe lines.	Alluwe, Chelsea, Cherokee, Muskogee, National Refining, Nowata, and other lines to refineries.	Shipped by rail and fuel consumption not included in pipe-line runs.	Total.
January	3,726,838	515,444	15,331	4,257,613
February	3,633,803	476,687	13,634	4,124,124
March	5,842,843	509,860	11,462	6,364,165
April	4,733,703	534,008	26,115	5,293,826
May	4,341,955	553,663	42,736	4,938,354
June	4,123,521	528,303	27,231	4,679,055
July	4,023,889	491,119	36,821	4,551,829
August	3,977,151	505,343	21,027	4,503,521
September	3,906,140	490,767	21,925	4,418,832
October	3,999,435	471,350	2,435	4,473,220
November	3,753,933	466,349	2,456	4,222,738
December	3,759,377	478,270	4,713	4,242,360
Total	49,822,588	[a] 6,021,163	225,886	56,069,637

[a] Quantity run by other lines averaged.

The following table gives a statement of the quantity of petroleum produced by the Indian Territory Illuminating Oil Co. and its sublessees from wells in Osage County from 1903 to 1911, inclusive:

Production of petroleum by the Indian Territory Illuminating Oil Co. and its sublessees from Jan. 1, 1903, to Dec. 31, 1911.

	Barrels.		Barrels.
1903	56,905	1908	4,961,147
1904	652,479	1909	4,516,524
1905	3,421,478	1910	5,892,970
1906	5,219,106	1911	11,707,676
1907	5,143,971		

Total production of petroleum and value of royalty oil and gas from wells in Osage County during the year 1911.

Received by—	Total quantity produced.	Amount received by Osage Nation for royalty of one-eighth of production.
	Barrels.	
Prairie Oil & Gas Co	10,197,717	$602,317
Gulf Pipe Line Co	636,373	37,752
Uncle Sam Oil Co	66,898	4,024
Southwestern Refining Co	41,635	3,033
The Texas Co	757,380	43,824
Groves, Stearns & Fisher	125	7
Finance Oil Co	1,500	82
Indian Territory Illuminating Oil Co	903	51
Barnsdall Oil Co	5,145	309
Total	11,707,676	691,399
Royalty received by Osage Nation for gas		3,489
Grand total		694,888

In the following table is shown the number of wells owned in Osage County by the Indian Territory Illuminating Oil Co. and its sublessees from 1903 to 1911, inclusive.

Oil and gas wells in Osage County, 1903–1911.

Total wells to—	Completed.	Productive.	Gas.	Dry.[a]
Jan. 1, 1903	30	17	2	11
Dec. 31, 1904	361	243	21	97
June 10, 1905	544	355	34	155
Dec. 31, 1905	704	462	45	197
June 10, 1906	862	569	55	238
Dec. 31, 1906	1,080	716	66	298
June 30, 1907	1,155	779	67	309
Dec. 31, 1907	1,277	837	71	369
Dec. 31, 1908	1,422	936	78	408
Dec. 31, 1909	1,574	1,027	81	466
Dec. 31, 1910	1,735	1,175	82	478
Dec. 31, 1911	2,233	1,562	90	581

[a] Wells which have been exhausted and abandoned in addition to wells that were dry when drilled in.

Glenn pool.—In the following table is given the production of petroleum in the Glenn pool (Creek County) for the last four years:

Estimated production and sales of petroleum from Glenn pool, 1908–1911, by months, in barrels.

Month.	1908	1909	1910	1911
January	1,796,461	1,362,602	1,745,206	1,099,192
February	1,897,054	1,410,878	1,543,660	967,924
March	2,098,411	1,543,463	1,974,514	2,584,464
April	1,968,761	1,467,179	1,674,709	1,570,947
May	1,630,111	1,590,730	1,676,366	1,069,863
June	1,051,045	1,809,989	1,573,578	958,519
July	1,914,134	1,856,524	1,557,869	965,122
August	1,770,819	1,699,486	1,609,702	981,946
September	1,639,252	1,670,167	1,593,986	937,886
October	1,832,033	1,602,988	1,521,794	969,247
November	1,404,234	1,539,342	1,400,118	864,519
December	1,491,998	1,393,392	1,365,412	910,489
Total	20,494,313	18,946,740	19,236,914	13,880,118

Well record.—The following table gives the well record for Oklahoma for 1910 and 1911, by districts and pools:

Well record in Oklahoma in 1910 and 1911, by districts and pools.

District and pool.	1910					1911				
	Wells completed.			Initial daily production.		Wells completed.			Initial daily production.	
	Total.[a]	Oil.	Dry.	Total.	Average per well.	Total.[a]	Oil.	Dry.	Total.	Average per well.
				Bbls.	*Bbls.*				*Bbls.*	*Bbls.*
Cherokee, deep sand	802	627	61	28,903	46.1	1,074	806	114	30,135	37.4
Bartlesville	251	232	11	10,196	43.9	188	165	15	4,955	30.3
Bird Creek	188	165	20	9,510	57.6	265	233	23	10,495	45.0
Copan	208	121	22	4,082	33.7	282	216	45	5,890	27.3
Hogshooter	155	109	8	5,115	46.9	339	192	31	8,795	45.8
Cherokee, shallow sand	1,830	1,665	152	85,147	51.1	1,576	1,381	109	70,221	50.8
Alluwe	190	182	7	4,645	25.5	98	93	4	1,674	18.0
Chelsea	351	322	25	7,920	24.6	138	124	11	1,935	15.6
Coodys Bluff	73	67	6	1,625	24.3	56	54	2	928	17.2
Collinsville	4	......	4	......	......	......	......	......	......	......
Delaware-Childers	757	673	80	59,185	88.0	650	597	43	54,266	90.9
Dewey	192	188	3	6,073	32.3	339	290	15	7,558	26.1
Nowata	109	103	4	2,150	20.9	149	88	25	1,202	13.7
Ochelata	99	81	17	2,274	28.1	50	42	6	975	23.2
Salt Creek	55	49	6	1,275	26.0	96	93	3	1,683	18.1
Cleveland	13	10	2	713	71.3	165	129	31	22,100	171.3
Creek	837	657	142	76,485	116.4	746	536	175	49,879	93.1
Beggs	3	......	3	......	......	43	21	15	4,065	193.6
Glenn Pool	84	72	6	4,505	62.6	46	37	9	4,650	125.7
Haskell	29	16	12	1,800	112.5	3	1	1	300	300.0
Keystone	12	7	5	405	57.9	8	5	3	190	38.0
Morris-Okmulgee	84	54	25	5,865	108.6	114	78	23	6,970	89.4
Muskogee	171	123	43	16,640	135.3	117	81	34	6,965	86.0
Preston	97	68	22	13,540	199.1	......	......	......	......	......
Redfork	1	1	......	20	20.0	......	......	......	......	......
Sapulpa	......	......	......	......	......	44	30	14	3,225	107.5
Taneha	306	284	15	31,050	109.3	133	117	14	8,191	70.0
Tulsa	19	10	7	605	60.5	132	98	28	11,204	114.3
Turley	......	......	......	......	......	37	33	4	1,310	39.7
Twin Hills	31	24	4	2,055	85.6	46	28	14	2,715	96.9
Wagoner	......	......	......	......	......	23	7	16	94	13.4
Osage	239	206	25	35,060	170.2	494	438	40	89,660	204.7
Miscellaneous	56	23	26	330	14.3	32	4	20	338	84.5
Total	3,777	3,188	408	226,638	71.1	4,087	3,294	489	262,333	79.6

[a] Including gas wells.

Number of wells completed in Oklahoma, 1907–1911, by districts.

District.	Completed.[a]					Dry.					Oil.				
	1907	1908	1909	1910	1911	1907	1908	1909	1910	1911	1907	1908	1909	1910	1911
Cherokee, deep	941	690	652	802	1,074	65	53	62	61	114	815	605	519	627	806
Cherokee, shallow	1,537	1,281	1,724	1,830	1,576	120	94	169	152	109	1,403	1,180	1,535	1,665	1,381
Creek	1,261	683	733	837	746	109	106	114	142	175	1,106	525	582	657	536
Cleveland	.....	22	28	13	165	.....	7	3	2	31	.....	14	23	10	129
Osage	184	153	108	239	494	15	16	15	25	40	154	129	75	206	438
Miscellaneous	33	15	34	56	32	9	8	17	26	20	12	5	8	23	4
Total	3,956	2,844	3,279	3,777	4,087	318	284	380	408	489	3,490	2,458	2,742	3,188	3,294

[a] Including gas wells.

Number of wells completed in Oklahoma, 1907–1911, by months.[a]

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1907	153	174	249	404	356	362	399	364	439	464	351	241	3,956
1908	194	162	165	194	229	208	224	282	246	263	325	352	2,844
1909	310	288	345	388	374	279	243	239	205	198	200	210	3,279
1910	262	313	325	348	377	378	274	269	306	329	343	253	3,777
1911	290	309	375	479	436	364	313	275	301	275	367	303	4,087

[a] Including gas wells.

Number of dry holes drilled in Oklahoma, 1907–1911, by months.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1907	13	15	17	24	27	32	43	32	33	31	31	20	318
1908	23	11	21	24	22	25	18	38	28	21	25	28	284
1909	33	22	38	51	53	48	31	28	14	17	21	24	380
1910	25	48	41	41	36	40	31	17	50	28	28	23	408
1911	30	16	27	56	56	64	46	35	32	32	45	50	489

Total and average initial daily production of new wells in Oklahoma, 1907–1911, by districts, in barrels.

District.	Total initial production.					Average initial production per well.				
	1907	1908	1909	1910	1911	1907	1908	1909	1910	1911
Cherokee, deep	74,824	36,561	34,130	28,903	30,135	91.8	60.4	65.8	46.1	37.4
Cherokee, shallow	64,490	80,923	90,864	85,147	70,221	45.9	68.6	59.2	51.1	50.8
Creek	303,539	76,722	68,710	76,485	49,879	311.3	146.1	118.1	116.4	93.1
Cleveland	....	455	1,865	713	22,100	....	32.5	81.1	71.3	171.3
Osage	16,355	19,377	10,205	35,060	89,660	106.2	150.2	136.1	170.2	204.7
Miscellaneous	654	114	680	330	338	54.5	22.8	85.0	14.3	84.5
Total	459,862	214,152	206,454	226,638	262,333	131.7	87.1	75.3	71.1	79.6

Total initial daily production of new wells in Oklahoma, 1907–1911, by months, in barrels.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1907	17,700	21,829	29,063	36,690	52,157	47,697	44,683	40,166	55,371	46,643	41,608	26,255	459,862
1908	16,475	17,550	10,865	13,018	16,045	15,860	14,695	18,834	17,198	24,915	25,377	23,320	214,152
1909	21,745	21,820	21,220	20,910	21,020	18,120	16,350	15,480	14,190	11,683	12,225	11,691	206,454
1910	15,840	17,785	20,915	18,932	19,545	26,378	14,915	16,680	18,998	18,585	17,915	20,150	226,638
1911	23,366	23,615	40,539	30,440	28,190	23,970	16,255	12,121	14,709	18,165	17,223	13,740	262,333

GULF OIL FIELD.

GENERAL CONDITIONS.

The oil pools in southern Louisiana and southern Texas are distinguished from those farther north by the greater specific gravity and viscosity of the oils, which also contain significant amounts of asphalt and sulphur. Exceptional oils are found there free from both, but thus far not in commercial quantities. The occurrence of these paraffin oils has significance, however, in view of the fact that in northern Louisiana and northern Texas the condition reverses itself and while paraffin oils free from asphalt and sulphur there predominate, the heavier varieties also exist. Further, about one-third of the distance northward from the Gulf fields toward the lighter oil fields, oils are found in Louisiana which are intermediate in constitution as well as in geographic position. The just classification of such oils is difficult. It is still possible, however, to draw a well-defined line between the oils of the Gulf field and those to the north. The latter are grouped for commercial purposes with the Mid-Continent field.

It is well to call attention also to the prospect of difficulty in the geologic classification of these Texas and Louisiana deposits. The oils of the Gulf field have been found in association with certain saline domes which have been well described by Harris, Hayes, Fenneman, Kennedy, and others in detailed reports which are referred to at the end of this chapter. These oils are usually but not always asphaltic. Lately, however, an undoubted saline dome has been opened north of the others in St. Landry Parish, La., at Pine Prairie. Here there is a trace of asphaltic oil on the top of the dome, but the bulk of the product just west of the salt contains no asphalt. The known occurrence of saline domes still farther north increases the probability that the oil at Caddo may have a similar structural association, as claimed by A. C. Veatch before oil was discovered.

PRODUCTION.

The importance of the Gulf field was increased in 1911 by the opening of the Vinton pool in southwestern Louisiana and by further development of the Markham field in Texas, the result being a product for the field of 11,677,562 barrels in 1911 compared with 9,932,182 barrels in 1910, an increase of 17.57 per cent. The details are given in the following tables:

Production of petroleum in the Gulf field in 1910 and 1911, by months, in barrels.

Month.	1910			1911		
	Coastal Texas.	Coastal Louisiana.	Total.	Coastal Texas.	Coastal Louisiana.	Total.
January	645,045	131,863	776,908	791,023	361,268	1,152,291
February	578,583	133,000	711,583	664,773	681,407	1,346,180
March	635,709	154,469	790,778	716,369	641,020	1,357,389
April	623,732	122,327	746,059	719,800	356,730	1,076,530
May	641,371	130,624	771,995	726,334	322,264	1,048,598
June	627,690	130,185	757,875	677,234	231,109	908,343
July	636,685	178,758	815,443	670,290	210,156	880,446
August	692,787	166,370	859,157	646,449	182,608	829,057
September	708,697	140,056	848,753	606,749	191,075	797,824
October	748,441	165,294	913,735	601,784	199,569	801,353
November	784,227	135,928	920,155	555,469	151,966	707,435
December	858,613	161,728	1,020,341	576,696	195,420	772,116
Total	8,181,580	1,750,602	9,932,182	7,952,970	3,724,592	11,677,562

Production and value of petroleum produced in the Gulf field, 1902–1911, by States, in barrels.

Year.	Coastal Texas.		Coastal Louisiana.		Total.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
1902	17,465,787	$3,577,698	548,617	$188,985	18,014,404	$3,766,683
1903	17,453,612	7,002,165	917,771	416,228	18,371,383	7,418,392
1904	21,672,311	7,743,860	2,958,958	1,073,594	24,631,269	8,817,454
1905	27,615,907	7,190,658	8,910,416	1,601,325	36,526,323	8,791,983
1906	11,449,992	5,825,036	9,074,170	3,555,655	20,524,162	9,380,691
1907	11,410,078	9,680,286	4,950,221	4,024,183	16,360,299	13,704,469
1908	10,483,200	6,221,636	5,288,937	3,287,446	15,772,137	9,509,082
1909	8,852,527	6,399,318	1,030,713	1,474,089	9,883,240	7,873,407
1910	8,181,580	6,203,201	1,750,602	1,283,212	9,932,182	7,486,413
1911	7,952,970	5,705,659	3,724,592	2,015,089	11,677,562	7,720,748

Production of petroleum in the Gulf field, 1889–1911, in barrels.

Year.	Production.	Percentage of total production.	Increase.	Decrease.	Percentage.	
					Increase.	Decrease.
1889	48	....	....	....	....	....
1890	54	....	6	....	12.50	....
1891	54	....	....	....	....	....
1892	45	....	....	9	....	16.67
1893	50	....	5	....	11.11	....
1894	60	....	10	....	20.00	....
1895	50	....	....	10	....	16.67
1896	50	....	....	....	....	....
1897	50	....	....	....	....	....
1898	1,450	....	1,400	....	2,800.00	....
1899	530	....	....	920	....	63.45
1900	0	....	....	530	....	100.00
1901	3,593,113	5.18	3,593,113	....	....	....
1902	18,014,404	20.29	14,421,291	....	401.36	....
1903	18,371,383	18.29	356,979	....	1.98	....
1904	24,631,269	21.03	6,259,886	....	34.07	....
1905	36,526,323	27.11	11,895,054	....	48.29	....
1906	20,524,162	16.23	....	16,002,161	....	43.81
1907	16,360,299	9.85	....	4,163,863	....	20.29
1908	15,772,137	8.83	....	588,162	....	3.60
1909	10,883,240	5.94	....	4,888,897	....	30.00
1910	9,932,182	4.74	....	951,058	....	8.74
1911	11,677,562	5.30	1,745,380	....	17.57	....

TEXAS.

GENERAL CONDITIONS.

Petroleum occurs in three zones in Texas: (1) In the Gulf field, the pools extending from the eastern border in Orange County very irregularly to Starr County on the Mexican border, the chief pools being in Jefferson, Hardin, Liberty, Harris, Brazoria, and Matagorda counties. The pools occur in a certain relation to a series of saline domes that have been well described by various writers, including Hayes, Fenneman, Kennedy, and Harris. (2) In the Cretaceous in the neighborhood of Corsicana and on the Louisiana line in Marion County, where the conditions have also been described by Harris. (3) In Clay, Wichita, Wilbarger, and neighboring counties in the Permian "Red Beds," or at the top of the Pennsylvanian—probably both. There are many other oil localities scattered over many counties in the State, but the three well-separated fields referred to not only include the production of the State, but the oil characteristic of each is so well distinguished from either of the others as to make it commercially, as well as geographically, important to consider them separately. In brief, the oils of the coast are asphaltic, contain notable amounts of sulphur and too small proportions of gasoline and kerosene to make them very valuable for refining purposes in comparison with the other oils to the north, which are progressively lighter and contain less sulphur and asphalt. In the Corsicana district there are two grades of oil, the heavy oil of the Powell pool and the lighter oil in the immediate neighborhood of Corsicana itself. Neither contains as much sulphur or asphalt as the oils of the Gulf coast. The oils of the Henrietta (Clay County) and Electra (Wichita and Wilbarger counties) pools average about 41° B. gravity and show practically no sulphur or asphalt.

During 1911 prospecting for oil was very active in many parts of the State. Drilling was carried on in Angelina, Archer, Aransas, Baylor, Bell, Bexar, Bowie, Brazos, Brewster, Caldwell, Callahan, Chambers, Clay, Coleman, Dewitt, Duval, Erath, Falls, Foard, Gillespie, Gregg, Grimes, Hardeman, Hardin, Harris, Jasper, Jefferson, Kaufman, Leon, Liberty, McLennan, McMullen, Marion, Matagorda, Maverick, Montague, Nacogdoches, Orange, Pecos, Robertson, Rusk, Shackelford, Shelby, Starr, Stonewall, Trinity, Tyler, Uvalde, Walker, Waller, Washington, Webb, Wichita, Wilbarger, Wilson, and Young counties, but the chief interest in wildcat ventures centered in the development of gas at Mula Creek near Eagle Pass, and at Trickham, Coleman County.

The Markham field was also active. In the beginning of January, 1911, two new wells came in and one old one was made to produce again. Hardy Oil Co. No. 25, which is 150 feet southwest of the original Markham well, came in, making 500 barrels a day, and Producers Oil Co. No. 1 gave 800 barrels a day. The Pay Streak Oil Co. pumped its well with air, getting 2,500 barrels a day. Within the next few days No. 3 of the Producers Co., located 150 feet southwest of Producers No. 1, flowed 2,000 barrels a day, and the Pay Streak well declined to 1,800 barrels a day. On January 16, No. 26 of the Hardy Co., which had been a gas well, began to flow oil at the rate of 3,000 barrels a day and declined to 1,800 barrels on January 23. On February 9, No. 28, Hardy, came in, flowing 3,000 barrels, thus accentuating the erratic character of the field. During the year drilling was active with a net gain of over 25 per cent in the year's production.

The Electra, the Petrolia, and the Henrietta fields are located in the great belt of Permian "Red Beds" in northern Texas. They are included in a great grazing country as yet but little explored for oil. Doubtless other pools will be found in this belt, the local structure of which, on account of the peculiar stratigraphic conditions, will probably be determined only with difficulty.

Electra.—The developments near the town of Electra in Wichita County, 150 miles north of Fort Worth, proved of phenomenal interest and caused active leasing in all the counties in this part of the State.

On January 17 the Producers Oil Co. drilled in its No. 5 Waggoner tract, about 2 miles north of the town of Electra, Wichita County. This was the second producer and yielded 50 barrels a day at a depth of 1,825 feet. From this time drilling was extremely active, particularly by the Producers Oil Co., the Clayco Co., the Magnolia Co., and others. Oil had first been discovered in this region by Mr. Waggoner in drilling for water. In fact, oil in small quantities was an inconvenience in most of the water wells of this neighborhood. The oil is found in sands from 10 to 30 feet thick, principally at depths of 580, 965, 1,035, and about 1,900 feet. The wells yield from 50 to 1,200 barrels by natural flow. Natural-gas pressures are light as compared with those in the Petrolia and Henrietta pools, 40 miles to the east, although one or two good gas wells were reported near the end of the year. In September the field was credited with a production of 6,000 barrels a day, and in October a contract was let for a pipe line from Electra to Dallas, a distance of 160 miles.

In November Corsicana well No. 1 yielded 1,200 barrels a day initial production, and the total for the field was 9,000 barrels a day. The increase by November 13 brought the total daily production to over 12,000 barrels, an average of over 350 barrels to the well. The wells proved to be good staying properties. At the end of the year two pipe lines were in construction for the field, one to be built by the Texas Co. to Dallas and the other by the Pierce-Fordyce Association to its refineries at Forth Worth. Both of these lines will also ultimately be connected with the refineries at Port Arthur. The oil is of light gravity and shows by analysis made in the Survey the following results: Gravity, 41° B.; gasoline, 19 per cent; kerosene, 35 per cent; paraffin wax, 3.2 per cent. The unsaturated hydrocarbons amount to 4 per cent.

Toyah.—Drilling was continued during the first part of 1911 by the Producers Oil Co., about 17 miles north of Toyah in the vicinity of the shallow wells drilled by Charles Ross. Oil was found in gypsum at about 2,000 feet in one well, but a second well a few hundred feet to the north was dry and drilling in the field by the Producers Co. was suspended. This action is said to be partly due to the uncertainty as to title to oil in land bought from owners of the surface. The drilling of other operators in the field was not conclusive.

PRODUCTION.

In addition to the statement of the production of the Gulf field as a whole, the total production in Texas of all kinds of oil is given below. Owing to the developments at Markham and Electra, the decline for the State was arrested.

Production and value of petroleum in northern and coastal Texas, 1902–1911, in barrels.

Year.	Northern Texas.		Coastal Texas.		Total.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
1902	617,871	$420,399	17,465,787	$3,577,698	18,083,658	$3,998,097
1903	501,960	515,314	17,453,612	7,002,165	17,955,572	7,517,479
1904	569,102	412,360	21,672,311	7,743,860	22,241,413	8,152,220
1905	520,282	361,604	27,615,907	7,190,658	28,136,187	7,552,262
1906	1,117,905	740,542	11,449,992	5,825,036	12,567,897	6,565,578
1907	912,618	721,577	11,410,078	9,680,286	12,322,696	10,401,863
1908	723,264	479,072	10,483,200	6,221,636	11,206,464	6,700,708
1909	681,940	393,732	8,852,527	6,399,318	9,534,467	6,793,050
1910	717,686	402,554	8,181,580	6,203,201	8,899,266	6,605,755
1911	1,573,504	848,893	7,952,970	5,705,659	9,526,474	6,554,552

In the following table will be found the production of petroleum in Texas, by districts and months, for the years 1910 and 1911:

Production of petroleum in Texas, 1910–11, by districts and months, in barrels.

1910.

Month.	Northern Texas.				Coastal Texas.		
	Corsicana.	Henrietta.	Powell.	Total.[a]	Batson.	Humble.	Marion and Matagorda Counties.[b]
January	10,953	11,788	38,906	61,950	83,342	231,138	1,730
February	13,661	9,423	35,194	58,581	88,515	191,449	2,485
March	16,182	10,115	40,315	66,915	88,142	219,980	1,330
April	11,186	11,116	39,356	61,961	85,275	211,513	1,914
May	11,947	10,614	37,535	60,399	95,102	220,367	2,629
June	11,433	10,674	38,281	60,691	100,427	190,992	3,425
July	10,382	8,821	37,228	56,734	102,671	200,415	6,652
August	12,046	9,419	38,753	60,521	100,573	204,355	67,688
September	10,295	9,747	36,010	56,355	89,732	186,495	94,589
October	9,979	9,962	36,719	56,963	100,511	226,963	105,371
November	9,636	8,767	36,254	54,960	90,299	208,644	172,387
December	9,631	16,085	35,637	61,656	89,178	203,200	247,51
Total	137,331	126,531	450,188	717,686	1,113,767	2,495,511	707,71

Month.	Coastal Texas—Continued.					Total.
	Saratoga.	Sour Lake.	Spindletop.	Other.[c]	Total.	
January	86,556	112,241	118,740	11,298	645,045	706,99
February	79,076	100,234	104,568	12,256	578,583	637,16
March	89,813	110,737	111,897	13,810	635,709	702,62
April	92,862	113,975	107,156	11,037	623,732	685,6
May	86,790	123,540	100,983	11,960	641,371	701,77
June	89,148	137,991	94,413	11,294	627,690	688,3
July	88,243	139,392	87,428	11,884	636,685	693,4
August	87,066	138,799	83,777	10,529	692,787	753,3
September	87,030	146,200	93,042	11,609	708,697	765,0
October	80,436	132,490	91,128	11,542	748,441	805,4
November	79,146	130,618	92,448	10,685	784,227	839,1
December	78,182	132,506	96,856	11,175	858,613	920,2
Total	1,024,348	1,518,723	1,182,436	139,079	8,181,580	8,899,2

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[a] Includes South Bosque and Brown County.
[b] Includes Potters Point, Markham, and Big Hill.
[c] Includes Dayton, Goose Creek, Hoskins Mound, Piedras Pintas.

Production of petroleum in Texas, 1910–11, by districts and months, in barrels—Contd.

1911.

Month.	Northern Texas.					Coastal Texas.	
	Corsicana.	Henrietta.	Powell.	Electra.	Total.[a]	Batson.	Humble.
January	10,047	18,378	33,655	....	62,361	95,320	194,724
February	9,012	16,196	30,312	....	55,801	86,881	193,973
March	10,502	15,385	33,961	....	60,129	84,754	221,215
April	9,766	12,946	30,653	6,300	59,946	92,625	210,829
May	10,954	13,222	32,940	7,132	64,529	85,129	222,397
June	9,731	13,500	31,511	9,240	64,265	81,985	225,016
July	10,377	13,839	31,437	13,217	69,153	82,807	218,149
August	10,749	15,044	30,650	62,248	118,973	87,805	212,594
September	10,032	13,563	30,449	101,649	155,975	84,296	194,453
October	12,259	12,884	30,791	196,939	253,155	83,208	187,136
November	11,781	11,150	27,739	259,485	310,436	79,431	161,522
December	13,316	12,858	28,957	243,369	298,781	79,252	184,212
Total	128,526	168,965	373,055	899,579	1,573,504	1,023,493	2,426,220

Month.	Coastal Texas—Continued.						Total.
	Marion and Matagorda Counties.[b]	Saratoga.	Sour Lake.	Spindletop.	Other.	Total.[c]	
January	190,171	83,962	130,068	96,091	687	791,023	853,384
February	113,636	64,387	116,386	88,539	971	664,773	720,574
March	117,551	79,008	123,625	89,859	357	716,369	776,498
April	120,001	76,767	122,382	96,485	711	719,800	779,746
May	113,260	76,980	122,811	104,920	837	726,334	790,869
June	99,965	77,820	114,444	77,772	232	677,234	741,493
July	105,417	72,752	110,682	80,251	232	670,290	739,442
August	93,763	74,410	111,823	65,822	232	646,449	765,424
September	77,727	76,446	106,450	67,143	234	606,749	762,729
October	77,452	78,710	105,150	69,894	234	601,784	854,935
November	66,839	77,138	103,150	65,489	1,900	555,469	865,907
December	63,735	87,397	97,909	63,674	517	576,696	875,473
Total	1,239,517	925,777	1,364,880	965,939	7,144	7,952,970	9,526,474

[a] Includes South Bosque and Brown County.
[b] Includes Potters Point and Markham.
[c] Includes Dayton and Hoskins Mound, and Duval County.

The production of petroleum in Texas from 1902 to 1911, inclusive, has been as follows:

Production of petroleum in Texas, 1902–1911, by districts, in barrels.

Year.	Northern Texas.					Coastal Texas.		
	Corsicana.	Henrietta.	Powell.	Electra.	Total.[a]	Batson.	Dayton.	Humble.
902	571,059	....	46,812	....	617,871	....	....	....
903	401,817	....	100,143	....	501,960	4,518	....	....
904	374,318	65,455	129,329	....	569,252	10,904,737	....	....
905	311,554	75,592	132,866	....	520,282	3,774,841	60,294	15,594,310
906	332,622	111,072	673,221	....	1,117,905	2,289,507	92,850	3,571,445
907	226,311	83,260	596,897	....	912,618	2,164,453	108,038	2,929,640
908	211,117	85,963	421,659	....	723,264	1,593,570	39,961	3,778,521
909	180,764	113,485	383,137	....	681,940	1,206,214	17,647	3,237,060
910	137,331	126,531	450,188	....	717,686	1,113,767	9,582	2,495,511
911	128,526	168,965	373,055	899,579	1,573,504	1,023,493	4,344	2,426,220

[a] Includes other districts of northern Texas.

Production of petroleum in Texas, 1902–1911, by districts, in barrels—Continued.

Year.	Coastal Texas—Continued.						Total.
	Matagorda County.	Saratoga.	Sour Lake.	Spindletop.	Other.	Total.	
1902	....	44,838		17,420,949	....	17,465,787	18,083,658
1903	....	8,848,159		8,600,905	[a] 30	17,453,612	17,955,572
1904	151,936	739,239	6,442,357	3,433,842	[a] 50	21,672,161	22,241,413
1905	46,471	3,125,028	3,362,153	1,652,780	[a] 30	27,615,907	28,136,189
1906	3,600	2,182,057	2,156,010	1,077,492	77,031	11,449,992	12,567,897
1907	1,573	2,130,928	2,353,940	1,699,943	21,563	11,410,078	12,322,696
1908	62,640	1,634,786	1,595,060	1,747,537	31,185	10,483,200	11,206,464
1909	29,103	1,183,559	1.703,798	1,388,107	87,039	8,852,527	9,534,467
1910	455,999	1,024,348	1,518,723	1,182,436	381,214	8,181,580	8,899,266
1911	561,828	925,777	1,364,880	965,939	680,489	7,952,970	9,526,474

[a] Bexar County.

The following table gives a statement of the production and value of petroleum at wells in Texas in 1910 and 1911, by districts:

Production and value of petroleum in Texas, 1910 and 1911, by districts, in barrels.

District.	1910			1911		
	Quantity.	Value.	Price per barrel.	Quantity.	Value.	Price per barrel.
Northern Texas;						
Corsicana	137,331	$87,623	$0.638	128,526	$74,439	$0.579
Henrietta	126,531	69,086	.546	168,965	92,046	.545
Powell	450,188	242,440	.538	373,055	186,528	.500
Electra	....	....	....	899,579	492,175	.547
Coastal Texas:						
Batson	1,113,767	851,927	.765	1,023,493	704,788	.68
Dayton	9,582	6,815	.711	4,344	2,946	.67
Humble	2,495,511	1,927,879	.773	2,426,220	1,864,598	.76
Matagorda	455,999	250,050	.548	561,828	305,588	.54
Saratoga	1,024,348	789,761	.771	925,777	739,247	.79
Sour Lake	1,518,723	1,203,920	.793	1,364,880	995,807	.72
Spindletop	1,182,436	961,758	.813	965,939	724,978	.75
Other Texas	[a] 384,850	214,496	.557	[b] 683,868	371,412	.54
Total	8,899,266	6,605,755	.742	9,526,474	6,554,552	.68

[a] Includes South Bosque and small production in Brown County in northern Texas and Goose Creek Hoskins Mound, Piedras Pintas, and Potters Point fields in coastal Texas.

[b] Includes South Bosque and small production in Brown County in northern Texas, and Duval County and Hoskins Mound and Potters Point fields, in coastal Texas.

PRICES.

In the following table are given the fluctuation in prices per barre for the various grades of petroleum produced in northern Texas ir 1909, 1910, and 1911:

Fluctuation in prices per barrel of petroleum in northern Texas, 1909, 1910, and 1911

Corsicana (light).		Henrietta.		Powell (heavy).	
1909.		1909.		1909.	
Jan. 1	$0.70	Jan. 1	$0.48	Jan. 1	$0.4
		Mar. 13	.50	Mar. 13	.5
1910.		Apr. 27	.53	Apr. 27	.
Jan. 1	.70				
May 23	.60	1910.		1910.	
Sept. 1	.58	Jan. 1	.53	Jan. 1	.
Nov. 16	.55	Mar. 16	.55	Mar. 16	.
				Sept. 1	.
1911.		1911.		Nov. 16	.
Jan. 1	.58	Jan. 1	.55		
				1911.	
				Jan. 1	.

The average monthly prices per barrel of petroleum at wells in northern Texas in the years 1909 to 1911, inclusive, were as follows:

Average monthly prices per barrel of petroleum in northern Texas, 1909–1911.

Month.	Corsicana (light).			Henrietta.			Powell (heavy).			Electra.
	1909	1910	1911	1909	1910	1911	1909	1910	1911	1911
January	$0.70	$0.70	$0.58	$0.48	$0.53	$0.55	$0.48	$0.53	$0.50	....
February	.70	.70	.58	.48	.53	.55	.48	.53	.50	....
March	.70	.70	.58	.49⅛	.54	.55	.49⅛	.54	.50	....
April	.70	.70	.58	.50½	.55	.55	.50½	.55	.50	$0.55
May	.70	.67	.58	.53	.55	.55	.53	.55	.50	.55
June	.70	.60	.58	.53	.55	.55	.53	.55	.50	.55
July	.70	.60	.58	.53	.55	.55	.53	.55	.50	.55
August	.70	.60	.58	.53	.55	.55	.53	.55	.50	.55
September	.70	.58	.58	.53	.55	.55	.53	.53	.50	.55
October	.70	.58	.58	.53	.55	.55	.53	.53	.50	.55
November	.70	.56½	.58	.53	.55	.55	.53	.51½	.50	.55
December	.70	.55	.58	.53	.55	.55	.53	.50	.50	.55
Average	.70	.62⅞	.58	.51⅝	.54⅝	.55	.51⅝	.53½	.50	.55

The average monthly prices per barrel of petroleum at wells in coastal Texas in the years 1909 to 1911, inclusive, were as follows:

Average monthly prices per barrel of petroleum in coastal Texas, 1909–1911.

Month.	Batson.			Dayton.			Potters Point.	
	1909	1910	1911	1909	1910	1911	1910	1911
anuary	$0.53-$0.60	$0.75-$0.79	$0.72-$0.73	$0.50	....	$0.70	....	$0.44
ebruary	.53- .60	.75- .80	.72- .72	.50	$0.72	.70	....	.44
arch	.53- 65	.75- .80	.72- .71	.50	.72	.70	....	.47
pril	.66- .73	.75- .80	.72- .70	.60	.72	.70	....	.50
ay	.73	.75- .80	.72- .69	.70	.72	.70	....	.54
une	.73	.75- .80	.70- .69	.70	.72	....	....	.58
uly	.74- .75	.75- .80	.66- .68	.71	.70	....	$0.38	.60
ugust	.75	.72- .79	.65- .68	.72	....	....	.40	.60
eptember	.75	.72- .79	.65- .67	.72	.70	....	.40	.61
ctober	.75- .77	.72- .79	.65- .67	.72	.70	....	.40	.62
ovember	.75- .77	.72- .79	.65- .66	.72	.70	.60	.41	.62
ecember	.75- .77	.72- .79	.65- .66	.72	.70	.60	.42	.62
Average	.706	.765—	.688	.65	.711+	.678	.408+	.55

Month.	Humble.			Saratoga.		
	1909	1910	1911	1909	1910	1911
anuary	$0.54-$0.60	$0.75-$0.80	$0.65-$0.78	$0.53 -$0.60	$0.75-$0.82	$0.70-$0.77
ebruary	.54- .65	.75- .80	.67- .77	.53 - .65	.75- .83	.69- .75
arch	.54- .70	.75- .80	.67- .76	.53 - .65	.75- .84	.70- .75
pril	.65- .75	.75- .80	.67- .76	.60 - .73	.75- .83	.69- .75
ay	.73- .75	.75- .80	.67- .77	.725- .73	.75- .83	.69- .75
ne	.74- .75	.75- .80	.67- .77	.725- .73	.75- .82	.70- .75
ly	.74- .75	.72- .79	.66- .75	.725- .75	.70- .79	.66- .75
ugust	.75	.72- .79	.65- .72	.75	.72- .77	.65- .74
ptember	.75	.72- .79	.65- .72	.75	.72- .77	.65- .75
ctober	.75- .78	.72- .79	.65- .72	.75 - .80	.72- .76	.65- .74
ovember	.75- .80	.72- .79	.65- .72	.75 - .80	.72- .79	.65- .74
ecember	.75- .80	.72- .79	.65- .72	.75 - .80	.72- .75	.65- .74
Average	.715	.773—	.768	.738	.771—	.798

Average monthly prices per barrel of petroleum in coastal Texas, 1909-1911—Continued.

Month.	Sourlake.			Spindletop.		
	1909	1910	1911	1909	1910	1911
January	$0.54-$0.60	$0.77-$0.84	$0.72-$0.78	$0.58-$0.60	$0.80-$0.82	$0.70-$0.79
February	.54- .65	.77- .84	.72- .80	.60- .65	.80- .82	.72- .79
March	.54- .70	.77- .84	.72- .80	.60- .70	.80- .82	.72- .78
April	.65- .75	.77- .83	.72- .80	.68- .75	.80- .83	.72- .76
May	.75	.77- .83	.72- .78	.75	.80- .83	.72- .76
June	.75	.77- .83	.71- .75	.75	.80- .83	.72- .76
July	.75- .76	.75- .80	.66- .75	.77- .80	.77- .83	.71- .74
August	.75- .77	.72- .80	.65- .75	.80	.77- .83	.70- .74
September	.75- .77	.72- .81	.65- .75	.80	.77- .83	.70- .74
October	.77- .80	.72- .79	.65- .75	.80- .82	.77- .82	.70- .73
November	.77- .80	.72- .76	.65- .75	.80- .82	.77- .82	.70- .73
December	.77- .80	.72- .76	.65- .75	.80- .82	.77- .82	.70- .73
Average	.721	.793—	.729	.751	.813+	.750

WELL RECORD IN NORTHERN TEXAS.

The following tables give the well records in northern Texas from 1908 to 1911, inclusive:

Number of wells completed in northern Texas, 1908-1911, by districts.

District.	Completed.				Dry.				Oil.			
	1908	1909	1910	1911	1908	1909	1910	1911	1908	1909	1910	1911
Corsicana	13	5	27	39	5	1	10	19	8	4	17	2
Electra	......	......	......	53	......	......	......	1	......	......	......	5
Henrietta	26	46	72	19	7	15	37	9	19	20	35	
Marion County	......	......	......	15	......	......	......	9	......	......	......	
Powell	42	118	91	......	12	28	35	......	30	87	56	......
South Bosque	......	2	......	......	......	1	......	......	......	1	......	......
Other	......	4	......	......	......	......	......	......	......	4	......	......
Total	81	175	190	126	24	45	*a* 82	38	57	116	108	

a Including gas wells.

Number of wells completed in northern Texas, 1908-1911, by months.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Tota
1908	3	8	6	11	5	7	5	6	5	10	7	8	
1909	6	4	......	8	22	20	21	11	19	14	31	13	*a* 1
1910	(*b*)	26	19	29	15	20	22	12	21	8	12	6	1
1911	9	15	10	22	3	......	10	6	9	7	14	21	1

a South Bosque not reported by months. *b* No record.

Number of dry holes drilled in northern Texas, 1908-1911, by months.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Tot
1908	1	1	1	4	1	3	2	2	3	3	1	2	
1909	6	2	......	4	4	5	4	4	7	4	11	7	
1910	(*a*)	6	6	9	5	8	14	6	10	6	7	5	*b*
1911	7	8	5	8	2	......	2	3	......	......	1	2	

a No record. *b* Includes gas wells.

Total and average initial daily production of new wells in northern Texas, 1908–1911, by districts, in barrels.

District.	Total initial production.				Average initial production per well.			
	1908	1909	1910	1911	1908	1909	1910	1911
Corsicana	41	25	54	107	5.1	6.2	3.2	5.4
Electra	....	....	....	15,550	....	....	....	304.9
Henrietta	718	484	1,331	69	37.8	24.2	38.0	9.9
Marion County	....	....	....	3,454	....	....	....	575.7
Powell	368	668	298	....	12.3	7.8	5.3	....
Total	1,127	1,177	1,683	19,180	19.8	10.8	15.6	228.3

Total initial daily production of new wells in northern Texas, 1908–1911, by months, in barrels.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1908	10	22	177	30	17	17	34	135	155	230	205	95	1,127
1909	0	50	0	45	117	133	227	73	74	154	248	56	1,177
1910	(a)	210	77	83	43	1,044	54	26	50	9	62	25	1,683
1911	4	3,265	12	567	200	......	428	450	2,300	2,209	5,250	4,495	19,180

[a] No record.

WELL RECORD IN COASTAL TEXAS.

The following tables give the well records in coastal Texas from 1907 to 1911, inclusive:

Number of wells completed in coastal Texas, 1907–1911, by districts.

District.	Completed.[a]					Dry.					Oil.				
	1907	1908	1909	1910	1911	1907	1908	1909	1910	1911	1907	1908	1909	1910	1911
Batson	206	53	51	65	36	32	10	11	14	10	174	43	40	51	23
Dayton	18	8	4	.....	.....	7	6	4	.....	.....	11	2	0	.....	.....
Goose Creek	.....	5	7	3	5	.....	3	2	2	4	.....	2	5	1	1
Hoskins Mound [b]	3	8	2	4	.....	3	6	1	2	.....	.....	2	1	2	.....
Humble	269	281	201	160	170	89	73	64	45	40	170	201	129	115	122
Markham	.....	10	2	16	41	.....	5	.....	7	9	.....	5	2	9	27
Matagorda (Big Hill)	6	.....	.....	.....	.....	5	.....	.....	.....	.....	1	.....	.....	.....	.....
Mission	7	5	.....	.....	.....	4	2	.....	.....	.....	3	3	.....	.....	.....
Piedras Pintas	4	.....	12	1	.....	.....	.....	10	.....	.....	4	.....	2	1	.....
Saratoga	98	44	31	37	56	12	4	4	7	10	86	40	27	30	45
Sourlake	156	81	146	95	101	35	8	29	12	21	120	72	116	83	76
Spindletop	122	108	82	100	93	21	26	36	27	23	101	82	46	73	58
Total	889	603	538	481	502	208	143	161	116	117	670	452	368	365	352

[a] Including gas wells.

[b] Includes West Columbia.

Number of wells completed in coastal Texas, 1907–1911, by months.[a]

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1907	68	63	97	85	52	74	69	73	81	86	77	44	869
1908	46	69	64	49	55	44	32	31	46	49	48	57	590
1909	48	51	54	49	52	35	45	52	45	37	38	32	538
1910	55	38	52	40	50	37	46	38	32	30	34	29	481
1911	41	46	46	44	41	76	51	41	33	25	29	29	502

[a] Including gas wells.

Number of dry holes drilled in coastal Texas, 1907–1911, by months.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1907	18	13	17	5	8	24	15	20	19	38	23	7	207
1908	10	16	16	8	10	23	12	10	12	6	7	13	143
1909	18	11	18	16	16	11	10	17	15	16	8	14	170
1910	14	16	9	11	20	11	11	10	7	1	3	3	116
1911	15	10	17	14	10	17	11	......	......	9	9	5	117

Total and average initial daily production of new wells in coastal Texas, 1907–1911, by districts, in barrels.

District.	Total initial production.					Average initial production per well.				
	1907	1908	1909	1910	1911	1907	1908	1909	1910	1911
Batson	18,004	2,806	2,179	2,328	606	103.5	65.2	54	45.6	26.3
Dayton	730	90	....	....	....	66.3	45	....	....	......
Goose Creek	....	500	54	100	250	....	250	11	100	250.0
Hoskins Mound	....	....	20	4,500	....	....	....	20	2,250	......
Humble	30,643	46,260	8,645	7,502	4,597	180.2	230.1	67	65.2	37.6
Markham	....	2,700	175	22,100	13,275	....	540	87	2,455.5	491.7
Piedras Pintas	....	....	175	150	....	....	....	87	150	......
Saratoga	11,487	5,135	3,590	2,137	2,309	133.5	128.4	13.3	71.2	51.3
Sourlake	12,481	7,376	12,737	16,388	4,463	104	102.4	11	197.4	58.7
Spindletop	10,452	9,385	5,725	8,078	7,240	103.5	114.4	12.4	110.7	124.8
Total	83,797	74,252	33,300	63,283	32,740	126.6	166.1	89.7	173.5	93.0

Total initial daily production of new wells in coastal Texas, 1907–1911, by months, in barrels.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1907	5,025	10,525	14,630	13,845	5,235	3,599	4,585	4,069	5,565	4,289	8,530	3,900	83,797
1908	6,200	6,040	6,045	5,100	4,565	5,435	5,835	5,485	6,865	6,117	9,020	7,545	74,252
1909	2,180	4,160	3,155	2,577	3,090	2,520	4,615	3,285	2,955	1,459	2,334	970	33,300
1910	3,048	3,135	1,150	5,540	2,935	4,457	8,570	3,940	3,500	4,590	13,835	8,583	63,283
1911	5,970	5,890	2,115	6,380	1,561	3,455	2,708	935	1,355	772	619	980	32,740

SHIPMENTS.

In the following table is given the shipment of petroleum by railroad in tank cars from the different stations of Texas during the year 1911:

Quantity of petroleum shipped by railroad in tank cars from the oil fields of Texas, at the stations named, by months, during the year 1911, in barrels.

Month.	Beaumont, Guffey.	Corsicana and Electra.	Danbury, Markham, Noledo, Christine.	Houston, Trice.	Humble.	Saratoga.	Sour Lake.	Total.
January	1,832	11,096	81,697	99,173	26,264	5,376	98,509	323,94
February	1,296	11,097	45,184	102,280	8,742	2,124	30,264	200,98
March	985	11,097	31,463	71,088	23,818	1,126	23,006	162,58
April	350	11,097	29,204	49,386	19,536	901	9,305	119,77
May	261	11,097	18,445	52,353	30,643	933	6,578	120,31
June	1,563	11,097	17,352	49,952	18,532	740	9,004	108,24
July	40,874	11,097	27,630	82,224	34,167	225	3,425	199,64
August	101,612	11,097	21,606	98,628	77,799	1,577	20,609	332,92
September	75,724	11,097	21,045	104,709	60,145	1,126	9,573	283,41
October	50,311	11,096	16,354	107,099	37,433	1,737	20,939	244,96
November	100,611	26,456	13,619	112,181	24,818	1,449	27,560	306,69
December	173,323	26,456	13,619	93,971	18,809	....	59,017	385,19
Total	548,742	163,880	337,218	1,023,044	380,706	17,314	317,789	2,788,69

EXPORTS.

The following tables, furnished by the Bureau of Statistics, Department of Commerce and Labor, give the exports of crude petroleum and its products from Texas, by months and kinds and by customs districts:

Exports to foreign countries of crude and refined petroleum from all ports of Texas in calendar year 1911, by months, in gallons.

Month.	Crude.		Naphtha.		Illuminating.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
January	2,759,937	$60,272	54,765	$8,612	5,722,258	$301,595
February	215,000	20,425	24,243	3,491	4,995,755	209,087
March	892,182	14,869	26,567	4,219	3,600,870	242,192
April			130,213	15,067	7,206,496	394,267
May	280,715	21,113	1,307,551	98,457	10,763,507	569,041
June	443,334	7,389	74,822	7,268	5,797,360	261,362
July	2,748,205	70,611	160,977	23,361	7,701,889	407,254
August	882,226	18,016	2,207,574	161,704	7,607,919	419,599
September			577,101	47,731	5,725,142	307,540
October	199,870	18,355	168,987	26,846	4,711,770	352,050
November			15,310	1,443	4,447,298	224,843
December	997,251	37,751	191,678	27,788	7,767,988	448,542
Total	9,418,720	268,801	4,939,788	425,987	76,048,252	4,137,372

Month.	Lubricating and paraffin.		Residuum.		Total.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
January	132,754	$25,413	6,273,643	$189,824	14,943,357	$585,716
February	32,873	5,333	998,604	23,776	6,266,475	262,112
March	124,745	24,879	5,772,498	176,134	10,416,862	462,293
April	134,942	24,485	3,666,521	134,221	11,138,172	568,040
May	89,218	14,652	2,890,722	90,402	15,331,713	793,665
June	20,265	4,714	3,404,095	110,169	9,739,876	390,902
July	136,575	27,451	1,930,058	67,543	12,677,704	596,220
August	140,960	26,471	7,264,914	254,272	18,103,593	880,062
September	67,752	13,533	2,679,252	75,133	9,049,247	443,937
October	128,064	24,793	5,173,747	170,089	10,382,438	592,133
November	63,175	12,733	1,240,309	43,215	5,766,092	282,234
December	116,234	23,469	3,335,945	117,273	12,409,096	654,823
Total	1,187,557	227,926	44,630,308	1,452,051	136,224,625	6,512,137

Exports of crude and refined petroleum from Texas, by customs districts, in calendar year 1911, in gallons.

Customs district.	Crude, including all natural oils.		Naphtha.		Illuminating.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Corpus Christi	81,750	$2,423	329,632	$32,383	8,610	$466
Brazos de Santiago			2,522	433	4,899	468
Galveston	726	44	39,241	5,137	735,400	40,484
Sabine	9,336,244	266,334	4,473,890	375,541	75,235,186	4,087,665
Paso del Norte			29,967	3,933	33,356	4,362
Saluria			64,536	8,560	30,801	3,927
Total	9,418,720	268,801	4,939,788	425,987	76,048,252	4,137,372

Exports of crude and refined petroleum from Texas, by customs districts, in calendar year 1911, in gallons—Continued.

Customs district.	Lubricating and heavy paraffin.		Residuum.		Total.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Corpus Christi	57,054	$7,468	43,526	$1,442	520,572	$44,182
Brazos de Santiago	19	16			7,440	917
Galveston	784,215	152,488	29,640	1,593	1,589,222	199,746
Sabine	279,614	50,217	44,557,142	1,449,016	133,882,076	6,228,773
Paso del Norte	11,573	4,077			74,896	12,372
Saluria	55,082	13,660			150,419	26,147
Total	1,187,557	227,926	44,630,308	1,452,051	136,224,625	6,512,137

LOUISIANA.

DEVELOPMENT.

In Louisiana the saline domes characteristic of the Gulf field of Texas yield oil in several localities in the southern parishes, and the occurrence of oil in considerable quantity has been established in saline domes farther to the north than in Texas. As in Texas, the Louisiana oils are progressively lighter to the north, and as no rock-salt dome has yet been discovered in the Caddo region, it is advisable, especially for commercial purposes, to keep that oil in a separate class as comparable with that of Electra, Tex. It should be noted that Caddo yields two sharply distinguished oils. About one-seventh of the average yield is heavy black fuel oil from the east side of the field. The other six-sevenths from the west half of the area is 41° to 43° B. and of Pennsylvania grade.

During 1911 the importance of the Caddo field was increased by the discovery of several phenomenally large wells. Three other discoveries also led to active drilling in the State. One was the development of large gushers at Vinton, in the southwest corner of the State; another was the development of a considerable gas field at Naborton, near Mansfield; and the third was the drilling of a gusher near the west end of the saline dome at Pine Prairie.

Vinton.—The sensation of the Gulf field was the development of the Vinton area, in southwestern Louisiana. At the beginning of the year the Gulf Refining Co. Gardner-Noble well came in with 7,200 barrels daily of pure oil, increasing the yield of the pool threefold Another gusher in February yielded 13,000 barrels a day. Late in February the Producers Oil Co. No. 2, Gray tract, came in with 2,000 barrels, making a total production of 20,000 barrels a day at the end of February. In the middle of March two gushers, one at 5,000 and the other at 4,000 barrels, further added to the production, and a well yielding 6,000 to 10,000 barrels a day extended the field half a mile to the west. By the end of the year the new wells were much less productive, and the total yield of the field had materially declined

Caddo Parish.—On December 31, 1910, the Texas Co. completed its 8-inch pipe line from the Caddo field to its refinery at Port Arthur, a distance of 218 miles. The pipe line was only commenced on August 1 This improvement in transportation facilities proved of great ai in the development which was to come in 1911, and which increased the total production of the field by nearly 1,000,000 barrels. At the beginning of the year this erratic field was producing 22,000 barrels a day, but within a month it had declined to 14,000 barrels. By the latter part of February the production had increased again to 15,500 barrels, and by the middle of March to 22,000, owing to four new wells giving a total new production of 8,000 barrels a day, more than offsetting the natural decline during the month. These wells were in sec. 3, T. 10, R. 16, which was the new pool opened by the Producers Oil Co. when it brought in Atlanta No. 1. The wells were Surrey No. 3 of the Gulf Co., 900 feet northeast of Atlanta No. 1 and 610 feet east of Surrey No. 2. The new well made 4,000 barrels a day at the start, and a week later was making 3,200. The Producers Oil Co. obtained a well known as Lane No. 1 on the Levee Board lease, 1,500 feet northwest of Atlanta No. 1. It began at 3,500 barrels, declining to 2,200 the next day. A good well was also obtained to the north of Atlanta No. 1, but the results to the south were not so favorable. Meanwhile, at the end of the year the pioneer wells of the district, although no longer gushers, were still most of them active; for example, No. 4, Stiles tract, in the Harts Ferry district, which was the discovery well of this West Caddo region, is being pumped with air and yields 175 barrels a day. Atlanta No. 1 still flowed at that time 1,700 barrels. No. 1, Burr tract, on the Texas side of James Bayou, was still making 650 barrels a day.

Confidence in the Caddo field was increased by the successful shutting in of one of the two wild gas wells. This was comparatively easily accomplished by drilling a well near by and pumping mud from it into the wild well. On March 23, the Higgins well, which had been drilled a month previous and had been flowing 2,500 barrels per day, was cleaned. It began flowing from 12,000 to 20,000 barrels a day. Control of it was lost for several days, but it was eventually shut in. The next event of the year was the obtaining on April 13 of Producers No. 16, Levee Board, which came in at 2,425 feet and flowed some 32,000 barrels, 55 per cent of it oil. This well is 500 feet south of Harrel No. 6.

The serious character of oil-field problems and the resourcefulness with which they are met was given forceful illustration when the Producers Oil Co. Harrel No. 7 well took fire on May 12, burning four men, one fatally, and offering the most difficult task ever known in the Caddo field. The well came in late the day before, flowing 20,000 barrels of oil a day with no water. While being partly closed, the well caught fire and burned at the rate of 8,000 barrels a day. Three batteries of six steam boilers each were installed in 36 hours, but were powerless. At the end of a week it was decided to tunnel to the well pipe and tap the oil off below the fire through the tunnel. This was finally accomplished.

De Soto Parish.—At the time when A. C. Veatch, in examining the underground water resources of northwestern Louisiana, predicted the discovery of oil and gas in what, due to his suggestion, finally became the Caddo pool, he acted on the assumption that a saline dome existed in the Caddo field, and he pointed out that other saline domes characterized the structure south and southeast of Caddo Parish.

The justification of this prediction came in 1911, when tests were made at Naborton and close to Mansfield. In the first part of January, 1911, the Spider Oil Co. began drilling a second test near Mansfield, and after passing several good gas sands, three in all, before reaching a depth of 900 feet, finally struck a heavy gas pressure at 1,500 feet in the middle of September. By the beginning of February, the Gulf, Producers, and Trees companies were also drilling in this region, and at Naborton the Christine Oil Co. began to drill. By July 20 the well was down 1,800 feet and had passed through three gas sands. By the middle of August the well reached 2,450 feet, and it was proposed to abandon it, and, as a third well gave a small amount of gas at a shallow depth, two additional wells were started to supply the demand at Mansfield. On continuing to drill, however, a heavy gas well was struck at a depth of 2,600 feet, yielding a supply sufficient for Mansfield. A charter was obtained for supplying that town at 35 cents per 1,000 feet. The Henry Oil Co. drilled another well near Washburn, which failed to prove up that property. S. A. Guy and the Robinson Oil Co., at Shreveport, began drilling operations at Washburn, and at Frierson another unsuccessful well was drilled. The interest aroused in these wells and the occasional showing of light oil in some of them have determined the drilling companies to test the region thoroughly. A gas field is assured with some prospect for oil. In fact, the number of wildcat operations in progress at the close of the year in northwestern Louisiana made it evident that the speculative element will not be content until the entire region between Alexandria and Shreveport has been tested.

Pine Prairie.—For three years the Myles Mineral Co. has been testing the saline dome described at this locality in the report of Prof. G. D. Harris. The first well near the apex of the dome passed through a small amount of heavy asphaltic oil and was in salt by 600 feet. A similar well to the west also struck the salt at too shallow a depth for successful oil drilling. One of these wells also passes through an interesting vein of sulphur. The next two wells were drilled too far to the west to strike the dome formation. Then three wells, 50 feet apart, were drilled in a row close to the supposed western limit of the dome. There were showings of oil in the first two, but they were not carefully tested. The eighth well was about to be abandoned when the successful efforts of John Champion, then employed in cleaning the hole, brought in a gusher with an initial flow estimated at 1,200 barrels a day. The oil is much lighter in gravity (32° Baumé) than the oil generally found only 200 feet east on the top of the dome. This well was brought in just after the close of 1911, and caused much interest. Eight other wells were soon started by the Gulf, Producers, and other companies, and the leasing of land extended for several miles in all directions.

Oil from the well recently drilled by the Myles Mineral Co., at Pine Prairie, La., has been examined in the laboratory of the United States Geological Survey with the following results:

Analyses of oil from Pine Prairie, La.

	Sample collected from tank.	Sample collected from well.	Typical Gulf coast oil, Sour Lake, Tex.	James Bayou oil from Caddo field.
Physical properties.				
Gravity at 60° F.:				
Specific	0.8626	0.8653	0.9272	0.8065
Baumé	32.3°	31.8°	21.0°	43.6°
Distillation by Engler's method.				
Begins to boil at ° C	175	173	185	95
By volume:				
To 150° C.—				
Volume per cent	....	....	....	15
Specific gravity	....	....	....	0.7275
150°-300° C.—				
Volume per cent	59	59	20	47
Specific gravity	0.8493	0.8493	0.8721	0.7770
Residuum—				
Volume per cent	40	41	79.4	40
Specific gravity	0.8980	0.9009	0.9409	0.8739
Total volume per cent	99	100	99.4	102
Paraffin do	0	0	0	7.02
Asphalt do	0	0	0.40	....
Sulphur do	0.15	0.15	....	....
Unsaturated hydrocarbons do	6.8	8.8	46.0	12.8

The analyses show that the Pine Prairie oil, although containing a very large percentage of illuminating oil (percentage boiling between 150° and 300° C.), is remarkable in containing no gasoline, no asphalt, and no paraffin wax.

The oil as it flowed from the well contained hydrogen sulphide gas, some of which probably escaped before the sulphur was determined. The amount of sulphur shown in the analyses represents what would usually be found after the oil had been stored in tanks for a short time.

The small percentage of unsaturated hydrocarbons is regarded as indicating that the oil may have been changed, with the loss of asphalt, by diffusion through clay in its passage from the saline dome to the sand stratum in which it was found.

In composition the oil stands about halfway between the oil of the Gulf field and Caddo oil.

PRODUCTION.

Both coastal Louisiana and the Caddo region showed important increases in 1911, bringing the State's total to 10,720,420 barrels for the year, the largest since the discovery of oil in that State. The next largest yield was in 1906, when the total was 9,077,528 barrels. Since then the product has declined until 1910, when the increase began again owing to the output of the Caddo field.

The following table shows the production of petroleum in Louisiana in 1910 and 1911, by districts and months:

Production of petroleum in Louisiana in 1910 and 1911, by districts and months, in barrels.

1910.

Month.	Jennings.	Welsh.	Anse la Butte.	Caddo.	Vinton.	Total.
January	127,058	4,528	277	121,629	....	253,492
February	128,013	4,525	462	150,674	....	283,674
March	145,877	4,528	4,064	212,770	....	367,239
April	116,564	4,528	1,235	262,211	....	384,538
May	125,477	4,528	619	406,058	....	536,682
June	120,306	4,528	5,351	587,523	....	717,708
July	170,849	4,724	3,185	481,344	....	660,102
August	148,619	4,724	13,027	354,355	....	520,725
September	130,133	4,528	5,395	771,744	....	911,800
October	158,287	4,528	2,479	764,123	....	929,417
November	118,426	4,527	6,067	501,866	6,908	637,794
December	135,550	4,528	1,857	476,496	19,793	638,224
Total	1,625,159	54,724	44,018	5,090,793	26,701	6,841,395

1911.

Month.	Jennings.	Welsh.	Anse la Butte.	Caddo.	Vinton.	Total.
January	128,196	1,440	2,167	437,546	229,465	798,814
February	111,221	1,487	1,857	348,683	566,842	1,030,090
March	121,330	2,214	2,627	475,387	514,849	1,116,407
April	100,697	1,993	3,560	430,159	250,480	786,889
May	94,050	2,843	4,643	574,203	220,728	896,467
June	83,585	2,823	5,597	677,403	139,104	908,512
July	82,158	3,012	2,321	711,012	122,665	921,168
August	80,459	3,032	6,810	599,157	92,307	781,765
September	82,486	2,800	10,758	731,306	95,031	922,381
October	101,037	2,087	12,321	791,868	84,124	991,437
November	72,641	2,085	2,786	652,675	74,454	804,641
December	122,317	2,085	6,964	566,429	64,054	761,849
Total	1,180,177	27,901	62,411	6,995,828	2,454,103	10,720,420

Production and value of petroleum in Louisiana in 1910 and 1911, by districts, in barrels.

District.	1910			1911		
	Quantity.	Value.	Price per barrel.	Quantity.	Value.	Price per barrel.
Coastal Louisiana:						
Jennings	1,625,159	$1,187,312	$0.731−	1,180,177	$781,762	$0.662
Welsh	54,724	46,047	.841+	27,901	23,793	.852
Anse la Butte	44,018	35,010	.795	62,411	47,557	.762
Vinton	26,701	13,351	.500	2,454,103	1,161,977	.473
Caddo	5,090,793	2,292,349	.450+	6,995,828	3,653,725	.522
Total	6,841,395	3,574,069	.522+	10,720,420	5,668,814	.529

Production of petroleum in Louisiana, 1902–1911, by districts, in barrels.

Year.	Coastal Louisiana.				Caddo.	Total.
	Jennings.	Welsh.	Anse la Butte.	Vinton.		
1902	548,617	....	....	....	....	548,617
1903	892,609	25,162	....	....	....	917,771
1904	2,923,066	35,892	....	....	....	2,958,958
1905	8,891,416	10,000	9,000	....	....	8,910,416
1906	9,025,174	23,996	25,000	....	3,358	9,077,528
1907	4,842,520	47,316	60,385	....	50,000	5,000,221
1908	5,111,577	31,555	145,805	....	499,937	5,788,874
1909	1,966,614	26,169	37,930	....	1,028,818	3,059,531
1910	1,625,159	54,724	44,018	26,701	5,090,793	6,841,395
1911	1,180,177	27,901	62,411	2,454,103	6,995,828	10,720,420

PRICES.

In the following table are given the prices paid for petroleum at wells in Louisiana in the years 1909 to 1911, inclusive:

Average monthly price of petroleum per barrel at wells in Louisiana, 1909–1911, by districts.

Month.	Jennings.			Caddo.			Vinton.	
	1909	1910	1911	1909	1910	1911	1910	1911
January	$0.60–0.70	$0.74–0.76	$0.62–0.70	$0.40	$0.59–0.60	$0.42–0.46	....	$0.40–0.50
February	.60– .67	.74– .76	.60– .70	.40	.59– .60	.44– .45	....	.41– .48
March	.63– .72	.72– .77	.61– .70	.40	.59– .60	.44– .50	....	.40– .49
April	.72– .76	.75– .87	.63– .70	$0.50–.52	.53– .60	.44– .50	....	.42– .51
May	.70– .75	.75– .87	.60– .70	.50–.55	.38– .56	.44– .55	....	.39– .51
June	.70– .75	.75– .87	.60– .70	.55–.57	.38– .44	.50– .60	....	.50– .52
July	.70– .75	.70– .74	.55– .70	.55–.60	.38– .42	.50– .60	....	.52– .56
August	.75– .86	.70– .74	.55– .70	.55–.60	.38– .42	.40– .60	....	.52– .52
September	.75– .86	.70– .71	.59– .70	.60	.38– .40	.40– .62	....	.52– .52
October	.75– .86	.65– .70	.60– .70	.60	.40	.40– .62	....	.51– .52
November	.75– .775	.67– .72	.60– .70	.60	.40– .42	.40– .62	....	.51– .53
December	.75– .775	.67– .73	.64– .70	.60	.42– .42½	.40– .62	....	.52– .53
Average	.723	.731	.662	.533	.450+	.522	$0.50	.473

WELL RECORD.

In the following tables are given the well records for Louisiana for the years 1907 to 1911, inclusive:

Number of wells completed in Louisiana, 1907–1911, by districts.

District.	Completed.					Dry.					Oil.				
	1907	1908	1909	1910	1911	1907	1908	1909	1910	1911	1907	1908	1909	1910	1911
Caddo	23	58	121	[a]226	341	4	9	33	54	63	8	43	69	124	246
Coastal Louisiana:															
Anse la Butte	4	16	9	4	1	2	9	4	1	1	2	7	5	3	.....
Jennings	76	142	51	22	5	23	38	23	6	1	53	104	28	16	4
Vinton	.....	.....	.....	11	96	.....	.....	.....	3	27	.....	.....	.....	8	54
Welsh	1	.....	2	5	10	.....	.....	1	.....	3	1	.....	1	5	5
Total	104	216	183	268	453	29	56	61	64	95	64	154	103	156	309

[a] Includes Marion County, Tex.

Number of wells completed in Louisiana, 1907–1911, by months.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1907	10	3	9	6	3	11	6	7	11	15	10	13	104
1908	11	26	18	25	24	13	9	23	18	20	14	15	216
1909	20	13	19	17	20	15	27	11	15	6	10	10	183
1910	16	14	22	24	18	22	21	33	26	15	25	32	268
1911	32	51	64	33	52	38	39	42	32	20	25	25	453

Number of dry holes drilled in Louisiana, 1907–1911, by months.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1907	5	3	6	4	1	4	......	1	2	7	1	6	40
1908	4	10	5	4	8	3	1	9	3	6	6	3	62
1909	6	8	6	9	7	6	15	2	10	2	4	5	80
1910	9	10	14	19	6	6	1	14	9	......	9	15	64
1911	12	15	12	6	9	6	9	8	3	4	5	6	95

Total and average initial daily production of new wells in Louisiana, 1907–1911, by districts, in barrels.

District.	Total initial production.					Average initial production per well.				
	1907	1908	1909	1910	1911	1907	1908	1909	1910	1911
Caddo	975	14,355	8,750	[a]139,945	169,123	121.9	333.8	127.0	1,128.6	687.5
Coastal Louisiana:										
Anse la Butte	3,040	5,200	955	735	....	1,520.0	742.8	191.0	245.0	....
Jennings	43,270	84,620	11,745	3,230	480	816.4	813.6	419.0	201.9	120.0
Vinton	....	....	....	11,100	73,550	....	....	1,387.5	....	1,362.0
Welsh	75	....	....	165	115	75.0	....	....	33.0	23.0
Total	47,360	104,175	21,450	155,175	243,268	740.0	676.4	210.3	994.7	787.3

[a] Includes Marion County, Tex.

Total initial daily production of new wells in Louisiana, 1907–1911, by months, in barrels.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1907	1,400	....	840	300	150	4,270	1,505	8,340	11,175	2,580	9,450	7,350	47,360
1908	2,010	10,160	19,330	15,255	21,945	2,165	3,390	3,770	10,400	8,195	1,990	5,565	104,175
1909	3,900	865	2,260	4,730	1,250	1,560	1,720	570	640	160	2,625	1,170	21,450
1910	1,750	1,345	5,320	3,520	11,040	20,650	8,270	12,245	33,560	30,840	16,215	10,420	155,175
1911	35,275	29,325	17,110	38,595	62,150	6,980	5,405	4,505	23,465	4,886	5,292	10,280	243,268

SHIPMENTS.

The following table gives a statement of shipments of petroleum from stations on the line of the Louisiana Western Railroad and of the Kansas City Southern Railway in Louisiana during the year 1911, by months:

Rail shipments of petroleum from stations on the lines of the Louisiana Western Railroad and the Kansas City Southern Railway in Louisiana in 1911, in barrels.

Month.	Anse la Butte.	Caddo oil.				Jennings oil.				Vinton.	Total.
		Lewis.	Mooringsport.	Oil City.	Vivian.	Egan.	Jennings.	Lake Charles.	Mermentau.		
January	1,315	163,765	190	28,266	36,721	2,167	26,052	....	17,680	203,498	479,654
February	1,238	141,054	....	36,909	34,747	1,857	21,391	7,869	50,224	292,728	588.017
March	3,095	187,545	640	29,594	53,775	2,627	17,635	118,929	2,549	303,871	720,260
April	3,560	69,128	258	32,509	26,792	3,560	14,404	4,029	66,785	240,205	461,230
May	4,333	47,353	640	11,753	32,504	4,643	21,360	....	70,968	164,155	357,709
June	310	65,303	....	3,293	30,722	5,597	22,382	....	68,028	185,770	381,405
July	1,083	149,958	....	9,740	24,762	2,321	10,624	....	18,810	176,252	393,550
August	1,702	130,483	658	63,594	38,964	6,810	10,345	....	15,619	126,259	394,434
September	1,587	44,060	383	66,530	40,206	10,758	12,819	....	33,809	72,958	283,110
October	1,083	32,560	876	53,787	40,614	12,321	12,064	....	16,956	54,059	224,320
November	1,676	28,666	....	56,746	21,020	2,786	14,297	....	18,393	58,016	201,600
December	1,209	31,428	....	55,855	22,645	6,964	17,173	....	43,115	39,105	217,494
Total	22,191	1,091,303	3,645	448,576	403,472	62,411	200,546	130,827	422,936	1,916,876	4,702,783

NOTE.—These are the official figures, calculation being made on the basis of 310.8 pounds of crude petroleum to a barrel of 42 gallons.

CALIFORNIA OIL FIELD.

DEVELOPMENT.

The petroleum industry is of such recent growth in California that the oil fields can be conveniently considered in the order of their development.

After a small production, chiefly of heavy fuel oil, for many years in Ventura, Santa Barbara, Los Angeles, and Fresno counties oil was discovered near Bakersfield, in Kern County, in 1899, and the Kern River field rapidly developed. This encouraged prospecting in many parts of the State and rapidly increased the production of the Coalinga field in Fresno County and developed the Santa Maria field in Santa Barbara County. Before this time much prospecting had been carried on in the west side of the San Joaquin Valley, developing the Sunset, Midway, and McKittrick fields. Meanwhile the Sherman, Whittier, and other more limited pools in and near Los Angeles had developed significant production. Finally during 1910 and 1911 oil was discovered in the La Habra Valley and in the Lost Hills and Elk Hills districts.

The discovery of oil has followed the investigation of seepages in many parts of the State from Humboldt County on the north, a distance of 650 miles, to San Diego on the south.

Developments in 1911.—At the close of 1910 oil was being produced in California at a rate greater than the average for the year. This increase continued, and the total production for the year 1911 was 81,134,391 barrels, compared with 73,010,560 barrels in 1910. Although the consumption also increased, production continued to exceed the demand, stocks increased to about 44,000,000 barrels, and prices receded to 30 cents a barrel where they were not governed by long-time contracts, although higher prices ruled for refining oils. The increased production was chiefly from the Temblor Range—western Kern County, from the pools already developed in 1910. Significant discoveries during the year were (1) the evidences of a large field in La Habra Valley, (2) the existence of an important field in the Belridge region along the edge of the San Joaquin Valley between McKittrick and the Lost Hills, and (3) the discovery at the end of the year in the Coalinga field of a zone of lighter oil 1,400 feet below the main producing beds in a lower geologic formation.

The Lake View gusher collapsed at the end of 1910. In the latter part of March the Associated Oil Co. drilled in sec. 13, T. 3, R. 10, in La Habra Valley, 3 miles from the old Fullerton field and in line with the developments in the Coyote Hills. Oil was found at 3,360 feet and the wells started at 600 barrels a day. This caused such activity in the region and such favorable results that in June the Fullerton field, including the new developments, was producing about half a' million barrels monthly. The oil sands seem thick and the wells promise to be persistent producers. The Standard Oil Co. promptly connected the field by pipe lines to its tank station at Wortham and by the end of the year completed the connection to the new refinery at El Segundo, near Los Angeles, the work on which began during the year. The refinery was practically completed and refining was begun by the end of December with a capacity of 5,000 barrels a day, to be rapidly increased. The Associated Oil Co. drilled test wells in the Elk Hills, San Joaquin Valley, in sec. 26, T. 30 S., R. 23 E., and in sec. 30, T. 30, R. 24, and obtained oil in both, with a likelihood of a production of several hundred barrels per day in at least the latter, thus proving the oil-bearing character of these hills, as had been predicted by the Government geologists. The oil was found at a depth of more than 3,000 feet and proved to be of 27° to 28° B., an unusually high gravity.

Important discoveries were made by drilling along the border of the San Joaquin Valley to the northwest of the McKittrick field, in the Belridge and Lost Hills fields, the result being a considerable extension of the possibly productive territory.

Interesting developments were also made in the Cat Canyon field. On November 25 the Union Oil Co. obtained a 3,600-barrel well of high-gravity oil. Transportation facilities in the California fields were increased by the line of the Associated Oil Co. from Canarez station to the Lost Hills.

Larger oil consumption.—The expected accumulation of stocks took place, but it is important to note the considerable increases in consumption. Among these were contracts with Arizona smelters for 60,000 barrels a month, made at the beginning of 1911; also in October the Canadian Pacific Railway was buying 20,000 barrels a month for use in terminal yards and on the steamers plying to the north. It is said to be the plan of this railway eventually to use oil exclusively for its passenger service as far as Kamloops, British Columbia. The year proved successful for the Independent Producers' Agency. After many methods for relieving the situation had been suggested, the association agreed to a plan for providing 10,000,000 barrels of storage, and at the end of the year contracts for building this storage had been made.

Inasmuch as the consumption has been increased beyond what was deemed probable at the beginning of the year, it can be considered that the critical conditions existing in California in 1911 have not been entirely without permanent benefit to the trade, which has now reached a position where the addition of even one or two large steamship companies to the ranks of oil burners, or equivalent consumption in other directions, would make the demand equal the present production. It is not too much to expect that unless a great increase in production takes place in 1912 the increase of manufactures and of domestic consumption will reduce the accumulated stocks.

PRODUCTION.

The following table shows the production and value of petroleum in California in 1910 and 1911, by districts and counties:

Production and value of petroleum in California in 1910 and 1911, by districts and counties, in barrels.

District and county.	1910			1911		
	Quantity.	Value.	Price per barrel.	Quantity.	Value.	Price per barrel.
Coastal and southern:						
Los Angeles County—						
Los Angeles city	441,639	$305,334	$0.691	397,424	$268,574	$0.676
Newhall	16,152,528	10,143,829	.628	16,247,804	10,281,176	.633
Puente						
Salt Lake-Sherman						
Whittier						
Orange County—						
Fullerton						
Ventura County—						
Santa Paula						
Santa Barbara County—						
Lompoc						
Santa Maria						
Summerland	71,511	44,742	.626	63,238	45,458	.719
San Luis Obispo County	60,405	38,175	.632	20,462	12,072	.590
Santa Clara County						
San Joaquin Valley:						
Fresno County—						
Coalinga	18,387,750	9,143,358	.497	18,483,751	9,100,371	.492
Kern County—						
Kern River	14,698,907	6,060,159	.412	13,225,713	4,922,735	.372
McKittrick [a]	5,604,653	2,140,070	.382	5,149,226	1,798,279	.349
Midway	10,436,137	5,122,375	.491	21,196,475	9,830,922	.464
Sunset	7,157,030	2,751,431	.384	6,350,298	2,459,493	.387
Total	37,896,727	16,074,035	.424	45,921,712	19,011,429	.414
Grand total	73,010,560	35,749,473	.490	81,134,391	38,719,080	.477

[a] Includes Lost Hills.

The following table shows the production of petroleum in Califorina, by counties, from 1902 to 1911, inclusive:

Production of petroleum in California, 1902–1911, by counties, in barrels.

Year.	Fresno.	Kern.	Los Angeles.	Orange.	Santa Barbara.	Ventura.	San Mateo.	Santa Clara.	Total.
1902	572,498	9,705,703	1,938,114	1,038,549	242,840	484,764	1,800	....	13,984,268
1903	2,138,058	18,077,900	2,087,627	1,413,782	306,066	348,295	5,137	5,607	24,382,472
1904	5,114,958	19,608,045	2,102,892	1,473,335	789,006	517,770	1,500	41,928	29,649,434
1905	10,967,015	14,487,967	3,469,433	1,429,688	2,684,837	337,970	50,563		33,427,473
1906	7,991,039	14,520,854	3,449,119	2,032,637	4,774,361	299,124	[a] 31,464		33,098,598
1907	8,871,723	15,652,156	3,477,235	2,604,982	8,708,077	357,094	[a] 77,108		39,748,375
1908	10,386,168	18,132,893	4,692,495	3,358,714	7,816,682	379,044	[a] 88,741		44,854,737
1909	14,795,459	23,831,768	16,774,195				[a] 70,179		55,471,601
1910	18,387,750	37,896,727	16,665,678				[b] 60,405		73,010,560
1911	18,483,751	45,921,712	16,708,466				[b] 20,462		81,134,391

[a] Includes oil produced in San Luis Obispo County.
[b] Production of Santa Clara and San Luis Obispo Counties.

Production of petroleum in California in 1910 and 1911, by districts and counties, with increase or decrease and percentage thereof, in barrels.

District and county.	1910	1911	Increase.		Decrease.	
			Quantity.	Per centage.	Quantity.	Per centage.
Coastal and southern:						
Los Angeles County—						
Los Angeles city	441,639	397,424			44,215	10.01
Newhall	16,152,528	16,247,804	95,276	0.59		
Puente						
Salt Lake-Sherman						
Whittier						
Orange County—						
Fullerton						
Ventura County—						
Santa Paula						
Santa Barbara County—						
Lompoc						
Santa Maria						
Summerland	71,511	63,238			8,273	11.57
San Luis Obispo County	60,405	20,462			39,943	66.13
Santa Clara County						
San Joaquin Valley:						
Fresno County—						
Coalinga	18,387,750	18,483,751	96,001	.52		
Kern County—						
Kern River	14,698,907	13,225,713			1,473,194	10.02
McKittrick	5,604,653	5,149,226			455,427	8.13
Midway	10,436,137	21,196,475	10,760,338	103.11		
Sunset	7,157,030	6,350,298			806,732	11.27
Total	37,896,727	45,921,712	8,024,985	21.18		
Grand total	73,010,560	81,134,391	8,123,831	11.13		

Production and value of petroleum in California, 1907–1911, by districts, in barrels.

Year.	Coastal and southern.		San Joaquin Valley.		Total.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
1907	15,224,496	$7,306,920	24,523,879	$7,393,036	39,748,375	$14,699,956
1908	16,335,676	9,296,743	28,519,061	14,136,759	44,854,737	23,433,502
1909	16,844,374	9,737,616	38,627,227	21,019,097	55,471,601	30,756,713
1910	16,726,083	10,532,080	56,284,477	25,217,393	73,010,560	35,749,473
1911	16,728,928	10,607,280	64,405,463	28,111,800	81,134,391	38,719,080

FIELD REPORT.

The field report for California for 1910 and 1911 is shown in the following table:

Field report for California in 1910 and 1911, by counties and districts.

1910.

County and district.	Wells.						Acreage.		
	Productive Jan. 1.	Completed in 1910.		Abandoned.	Productive Dec. 31.	Drilling Dec. 31.	Fee.	Lease.	Total.
		Oil.	Dry.						
Fresno County	644	161	8	11	794	148	44,618	50,297	94,915
Kern County:									
Kern River	1,393	283	5	8	1,668	22	8,168	6,796	14,964
McKittrick	208	25	10	2	231	15	6,831	17,641	24,472
Midway	208	212	4	12	408	230	25,818	29,432	55,250
Sunset	190	57	2	4	243	67	36,354	1,932	38,286
Devils Den Lost Hills	1	1	......	....	2	7	3,880	....	3,880
Los Angeles County:									
Los Angeles city	451	......	......	24	427	1	77	61	[a] 138
Newhall-Puente	131	5	2	1	135	11	6,522	4,433	10,955
Salt Lake-Sherman	246	38	7	8	276	20	13,811	3,891	17,702
Whittier	124	......	1	3	121	6	5,099	148	5,247
Orange County	242	13	1	....	255	36	10,788	4,838	15,626
San Luis Obispo County	13	2	2	4	11	8	8,759	11,893	20,652
San Mateo County	4	......	......	....	4	1	....	600	600
Santa Clara County	4	1	......	....	5	2	153	6,000	6,153
Santa Barbara County:									
Lompoc-Santa Maria	220	22	4	1	241	45	32,465	153,718	186,183
Summerland	124	......	......	4	120	....	16	22	38
Ventura County	242	20	4	17	245	32	29,147	92,483	121,630
Miscellaneous	2	......	......	....	2	10	....	....	....
Total	4,447	840	50	99	5,188	661	[b] 232,506	384,185	616,691

1911.

Fresno County	794	192	22	30	956	....	32,165	12,745	44,910
Kern County:									
Kern River	1,668	153	6	34	1,787	....	14,889	1,871	16,760
McKittrick	231	24	7	9	246	....	40,183	1,888	42,071
Midway	408	333	21	49	692	....	32,352	26,427	58,779
Sunset	243	94	7	7	330	....	17,493	12,844	30,337
Devils Den Lost Hills	2	24	4	6	20	....	6,980	880	7,860
Los Angeles County:									
Los Angeles city	427	10	......	24	413	....	318	25	343
Newhall-Puente	135	2	6	4	133	....	5,642	4,990	10,632
Salt Lake	276	15	5	3	288	....	12,420	3,023	15,443
Whittier	121	5	1	17	109	....	5,088	154	5,242
Orange County	255	29	......	36	248	....	11,807	6,383	18,190
San Luis Obispo County	11	1	5	9	3	....	3,565	2,661	6,226
San Mateo County	4	......	......	....	4	....	....	....	....
Santa Clara County	5	1	......	2	4	....	56	6,000	6,056
Santa Barbara County:									
Lompoc-Santa Maria	241	19	11	5	255	....	93,291	36,839	130,130
Summerland	120	42	......	1	161	....	11	13	24
Ventura County	245	19	5	9	255	....	44,369	92,570	136,939
Miscellaneous	2	......	4	1	1	....	5,380	28,239	33,619
Total	5,188	963	104	246	5,905	....	[c] 326,009	237,552	563,561

[a] Acreage in town lots.

[b] Includes 70,194 acres of oil locations.

[c] Includes 37,827 acres reported as oil locations.

COLORADO OIL FIELD.

DEVELOPMENT.

Oil has been found in Fremont, Boulder, Mesa, Rio Blanco, Routt, Pueblo, and Archuleta counties and is produced commercially in the first two. In both the oil occurs in the Pierre shale of the Montana group (Upper Cretaceous), and is found, especially in the Florence field in Fremont County, in crevices in steeply inclined shale at considerable depth, the wells ranging from 2,850 to 3,600 feet. Four pay streaks have been developed by some of these wells; other deep wells have failed to find oil. The Florence oil is 31° to 32° Baumé and dark green in color. The quality is satisfactory for refining.

In 1901 several wells were drilled near Boulder, 30 miles northwest of Denver, which opened this so-called Boulder field. Oil was found at between 2,700 and 2,900 feet in the Pierre shale. The oil produced is remarkable for its high gravity (42.5° Baumé). It is Pennsylvania grade. This discovery stimulated drilling in many parts of the State—in Boulder, Archuleta, Routt, Gunnison, Jefferson, Arapahoe, El Paso, La Plata, Saguache, Elbert, Logan, and Pueblo counties. A considerable field of high-grade oil has been developed in the Rangely district of Moffat and Rio Blanco counties, but production in this field was limited to the quantity required for drilling wells because of lack of transportation. The development of the field is waiting upon the completion of the Moffat road or other rail transportation. Small wells have been drilled near Debeque, but the Florence and Boulder fields remain the sources of the oil supply in Colorado.

PRODUCTION.

In the following table is given the production of petroleum in Colorado, by fields and months, in 1910 and 1911.

Production of petroleum in Colorado in 1910 and 1911, by fields and months, in barrels.

Month.	1910				1911			
	Boulder.	Florence.	Other.[a]	Total.	Boulder.	Florence.	Other.[a]	Total.
January	2,032	15,394	340	17,766	3,390	15,483	134	19,007
February	3,102	12,916	386	16,404	2,553	13,612	134	16,299
March	5,212	18,332	340	23,884	3,337	16,066	134	19,537
April	4,826	20,260	340	25,426	3,343	15,989	134	19,466
May	3,645	17,622	340	21,607	2,749	14,375	135	17,259
June	3,586	14,669	340	18,595	1,902	14,280	135	16,317
July	3,646	16,257	340	20,243	3,331	16,042	135	19,508
August	2,795	16,501	340	19,636	2,625	16,810	135	19,570
September	2,527	14,997	340	17,864	2,701	17,047	134	19,882
October	3,966	15,535	340	19,841	4,922	17,736	134	22,792
November	3,031	14,922	340	18,293	3,804	15,986	134	19,924
December	3,818	16,077	340	20,235	3,316	13,915	134	17,365
Total	42,186	193,482	4,126	239,794	37,973	187,341	1,612	226,926

[a] Averaged.

In the following table will be found the production and value of petroleum in the Boulder and Florence fields in Colorado from 1902 to 1911, inclusive:

Production and value of petroleum in Colorado, 1902–1911, by districts, in barrels.

Year.	Boulder.		Florence.		Total.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
1902	11,800	....	385,101	....	396,901	$484.683
1903	36,722	....	447,203	....	483,925	431,723
1904	18,167	$20,034	483,596	$558,001	501,763	578,035
1905	10,502	11,502	365,736	326,104	376,238	337,606
1906	48,952	53,847	278,630	208,828	327,582	262,675
1907	68,353	75,188	263,498	197,625	331,851	272,813
1908	84,174	124,794	295,479	221,609	379,653	346,403
1909	85,709	129,812	225,062	187,900	[a] 310,861	318,162
1910	42,186	63,420	193,482	174,332	[b] 239,794	243,402
1911	37,973	50,393	187,341	175,763	[b] 226,926	228,104

[a] Includes a small production in Garfield County.
[b] Includes production of Garfield and Rio Blanco counties.

FIELD REPORT.

Drilling was active in Colorado in 1911, as shown by the following table of wells which were productive at the beginning of 1911 and of those drilled during the year. The acres of land owned and leased in the State are also shown.

Field report for Colorado in 1911, by counties.

County.	Wells.					Acreage.		
	Productive Jan. 1.	Completed in 1911.		Abandoned.	Productive Dec. 31.	Fee.	Lease.	Total.
		Oil.	Dry.					
Boulder	24	6	8	3	27	3,943	900	4,843
Fremont	56	4	9	6	54	5,187	10,440	15,627
Rio Blanco	35	4	1	....	39	4,000	8,800	12,800
Other	1	....	....	....	1	100	....	100
Total	116	14	18	9	121	13,230	20,140	33,370

WYOMING OIL FIELDS.

DEVELOPMENT.

Petroleum seepages have been found in many localities in Wyoming. There are five widely separated productive areas, as follows:

EVANSTON-SPRING VALLEY FIELD.

The Evanston-Spring Valley field is in Uinta County. Here a high-grade petroleum with a specific gravity of 40° to 44° Baumé occurs in a certain relation to a large fault, which has been described by A. C. Veatch in Bulletin 285 of the United States Geological Survey. At Spring Valley the oil is found in sandy layers in a black shale. This black shale occurs in the basal portion of the Benton group. In general no oil is found along the outcrop of this bed, but the amount increases with the dip. No water has been found in the oil-bearing beds, therefore, with tendency of oil to move down the dip when water is absent, the syncline here becomes the interesting place of search for oil. At Hilliard the lowest point in the shale bed is beyond reach—11,000 feet. Toward Aspen tunnel the axis of the syncline rises, and the beds may be prospected at 2,500 to 3,000 feet. Ten to fifteen miles north of Kemmerer the rise is sufficient for favorable search. A lower horizon developed in a light-blue shale, probably Jurassic. The oil is black and thicker than that from the higher formation. The lighter oil is practically free from sulphur and yields 21.3 naphtha and 39.7 per cent of burning oil (Mabery). Thus far drilling has not been sufficient to define the field thoroughly, and it is impossible to predict its future.

BIGHORN FIELD.

The Bighorn field is in Bighorn County. Here high-grade oil for refining, with much natural gas, was developed in 1907, and since then 27 wells have been drilled and a regular production established. The region has been described in detail by C. W. Washburne in Bulletin 340 of the United States Geological Survey.

LANDER FIELD.

The Lander field in Fremont County yields chiefly heavy fuel oil with an average gravity of 220° to 240° Baumé, though 50 miles to the north the Plunkett well shows a light paraffin oil of 42.40° Baumé. E. G. Woodruff describes this field in Bulletin 452 (1911) of the United States Geological Survey, as follows:

> *Location and extent of the field.*—The Lander oil field is a rectangular area in central Wyoming, 39 miles long and from 3 to 11 miles wide, embracing 200 square miles. It lies in Fremont County and extends N. 30 W. from near the middle of T. 31 N., R. 98 W., sixth principal meridian, to T. 2 N., R. 1 W., Wind River meridian. Lander is the largest town and the principal trading point of the region. It is the terminus of the Wyoming & Northwestern Railway (Chicago & North Western system) and the point from which stage lines start northwest and southeast across the field. Hudson is a coal-mining town in the valley of Big Popo Agie River, on the northeastern side of the field. Fort Washakie and Wind River are trading posts in the northwestern part of the area, and Dallas is a post office at a ranch house in the southeastern district. The part of the field northwest of Big Popo Agie River is in the Shoshone Indian Reservation, and development in that area can take place only under lease from the Indians and subject to the regulations of the United States Office of Indian Affairs.
>
> For convenience in description the field is divided into three districts, which coincide in a general way with the three natural and commercial subdivisions of the field, * * * the Little Popo Agie district (Popo Agie field of Knight), Big Popo Agie district (Lander field of Knight), and the Little Wind River district (Shoshone field of Knight). The change of names indicated seems advisable, because the field is now commercially known as the Lander field, and it seems best to consider the area as one field rather than three, because it is controlled by one continuous structural feature with minor modifications.
>
> The Little Popo Agie district occupies the entire southeastern part of the field and extends northwestward to a line midway between Big and Little Popo Agie rivers. Practically all the development work in the field has been done in this area, and a pipeline is now completed from the oil wells near Dallas to the railroad at Wyopa.
>
> The Big Popo Agie district comprises the central part of the field and extends from the Little Popo Agie district to a line midway between Big Popo Agie and Little Wind River. It is crossed by the railroad and contains the terminus of the pipe-line from

the Little Popo Agie district. Until the summer of 1909 the only well in the central part of the field was in Big Popo Agie Valley near the river, but early in that summer a well was located on the crest of the anticline in the western part of the district. It was not finished when the area was examined, but subsequent reports from the operators state that oil was found at a depth of 250 feet. This well is close to the site of the Washakie oil spring, which has long been famous because of the medicinal properties of the oil.

The Little Wind River district includes the northwestern part of the field. It contains the hot spring near Fort Washakie and the tar spring to the north, across the river. One abandoned well is located at the site of the tar spring and another well was being drilled in the valley of Sage Creek at the time the field was examined [1909].

SALT CREEK FIELD.

(4) The Salt Creek field is in Natrona County, and for some years has yielded heavy oil suitable for lubrication and for fuel. On account of its rapidly increasing importance it was carefully studied by Carroll H. Wegemann in 1909 and described in Bulletin 452 (1911) of the United States Geological Survey.

Location of the field.—The Salt Creek oil field is located in Tps. 38 to 41 N., Rs. 78 and 79 W. of the sixth principal meridian, in the northeast corner of Natrona County, Wyo. It lies in the drainage basin of Powder River, about 50 miles due north of Casper and 80 miles southeast of Buffalo.

Oil was reported in this area even prior to 1880. Development was first begun by P. M. Shannon of the Pennsylvania Oil & Gas Co. The first well was drilled in 1889 and shipment was begun in 1893 by wagon to Casper. In 1895 the Pennsylvania Oil & Gas Co. erected a refinery at Casper and continued the drilling of 13 wells, which yielded a heavy lubricating oil, olive green in color by reflected light, with specific gravity of 0.9097 (23.9 Baumé). It contains little or no naphtha, asphalt, or sulphur, but more than 1 per cent of paraffin wax.

The property changed hands in 1905. After a report by an Italian geologist in 1906 a well was drilled by a Holland company about 3 miles south of the Shannon wells and farther up the flank of the dome. Oil was obtained under great pressure in sandstone at about 1,000 feet depth. This oil, in contrast to that obtained from the Shannon wells, is a light gasoline oil containing 16 per cent of naphtha, 29 per cent of water-white oil, and 6 per cent of paraffin. Its color is very dark green by reflected light and reddish brown by transmitted light.

Since that time development work has been active. During 1911, 25 wells were drilled in this field with progressively better results, and still further interest was aroused by the drilling in of much larger gushers after the opening of 1912.

POWDER RIVER FIELD.

(5) In 1910 the Powder River oil field, in Johnson County, was examined by Carroll H. Wegemann and a party from the United States Geological Survey. Practically all the indications of oil occur in T. 41 N., R. 81 W., and in the northern part of T. 40 N., R. 81 W. The distribution of the oil is controlled by a structural dome, much resembling that of the Salt Creek field. This dome lies some 15 miles southeast of the Salt Creek dome, but the strata in which oil occurs in the Powder River field are lower in the geologic column than the producing beds at Salt Creek. The oil is a heavy lubricating

oil somewhat higher in specific gravity than the heaviest oil at Salt Creek. It is black and contains more than 2 per cent of asphalt and about 20 per cent of kerosene, but no naphtha.

PRODUCTION.

The following table gives the production in Wyoming from 1902 to 1911, inclusive:

Production of petroleum in Wyoming, 1902–1911, in barrels.

Year.	Quantity.	Year.	Quantity.
1902	6,253	1907	[b] 9,339
1903	8,960	1908	[b] 17,775
1904	11,542	1909	[b] 20,056
1905	8,454	1910	[b] 115,430
1906	[a] 7,000	1911	[b] 186,695

[a] Estimated.

[b] Includes the production of Utah.

FIELD REPORT.

The field report for Wyoming in 1911 is shown in the following table:

Field report for Wyoming in 1911, by counties.

County.	Wells.					Acreage.			
	Productive Jan. 1.	Completed in 1911.		Abandoned.	Productive Dec. 31.	Locations.	Fee.	Lease.	Total.
		Oil.	Dry.						
Bighorn	22	1	4	7	16		1,960	2,390	4,350
Converse	6			1	5		500		500
Crook	9	3		1	11	1,240	640		1,880
Fremont	39	2		4	37		100	12,740	12,840
Johnson	1				1		160		160
Natrona	52	25		3	74		3,520	1,760	5,280
Uinta	20	6	5	1	25		4,840	9,700	14,540
Total	149	37	9	17	169	1,240	11,720	26,590	39,550

UTAH.

DEVELOPMENT.

Oil has been produced in Utah in both the Virgin field on the eastern edge of Washington County and in the San Juan field in the southern part of San Juan County, and interesting occurrences of oil have also been noted in the Dragon field on the eastern edge of Uinta County, near the town of that name, and in the field about 15 miles west of Vernal. Natural gas has also been noticed and even obtained to a slight extent by drilling on the east shore of Great Salt Lake. In the northeastern part of Great Salt Lake a well is being drilled for asphaltic oil. In addition, considerable wildcat drilling has been carried on for the last two or three years in the San Pete Valley near Juab and Mount Pleasant. The Virgin oil field has already been described in this series of reports.

During 1910 a careful examination was made of the San Juan oil field by E. G. Woodruff and a detailed description of it is published by him in Bulletin 471 of the United States Geological Survey (1912).

San Juan River has cut a deep gorge across the field and exposed with remarkable clearness more than 1,400 feet of Paleozoic strata in a nearly horizontal position. Erosion has swept away the softer beds above the Paleozoic from the greater part of the field, but these beds are exposed in great escarpments on the north and the east. More than 5,000 feet of strata, ranging from Carboniferous to Jurassic, inclusive, are exposed in the field.

All of the oil is found in Paleozoic rocks in the Goodridge formation (Carboniferous), which is the lowest formation exposed in the canyon cut by the San Juan River. This formation consists of limestone, sandstone, and sandy shale, which are exposed in the canyon in the western part of the field. The oil generally occurs in sandstone, though traces have been found in limestone in several wells. The formation contains nine beds of sandstone, all of which have been supposed by the prospectors in the field to contain enough oil to supply wells when they are drilled. Mr. Woodruff was unable to verify this supposition, but is inclined to believe that all the sandstone beds contain some oil, but in most of them in quantity insufficient to warrant exploitation. The "Goodridge" sand is reported to be one of the most productive oil sands in the field. It is 26 feet thick along the Honaker trail, and seems to be fairly uniform throughout the field. It is made up chiefly of grains of clear quartz with calcareous cement and seems to be generally porous. The structure of the San Juan oil field is only moderately complicated by north-south folds. The beds, in the western part of the field, lie approximately horizontal or dip very gently to the west. Near the central north-south line of the field they are moderately depressed into a syncline, the eastern limb of which rises abruptly and merges with the western slope of a slightly elevated flat-topped anticline. On the east side of the anticline the strata dip abruptly to the edge of the field, but a short distance beyond the eastern border the beds are flexed sharply again into a horizontal position and maintain that general attitude far to the east. The strata are folded most near the center of the field and gradually flatten into horizontal beds along both the north and south sides of the field. The apex of the anticline is south of San Juan River and southeast of Mexican Hat Butte and the lowest point in the syncline is a short distance south of the river, on the axis of the syncline.

As there seems to be little water in the strata of the field, it is assumed that the oil collected in the syncline, or at least not far up the sides. Accordingly, it is believed that the chance of finding oil is better in the syncline than it is in the anticline.

Oil springs.—Along San Juan River, west from Goodridge to the boundary of the field, there are several oil springs. All these springs are near the level of the river but not in the same strata, because the beds rise to the west and the river cuts into successively lower beds, some of which are oil sands and give rise to oil springs. The highest seeps stratigraphically that were noted in the field are from the "Goodridge" oil sand, where it is exposed along San Juan River, near Goodridge Bridge, and the lowest reported is at the foot of the Honaker trail. The stratigraphic distance between these two springs is 1,450 feet. The group of springs in the "Goodridge" sand occurs at intervals for about 200 feet along the river near the bridge. The seeps are discharging a little oil, which impregnates small areas of the rocks. At some places the oil seems to follow crevices; at others it saturates the unbroken rock. It is to be noted also that the oil does not come from any distinct horizon in the sandstone, as proved by the presence of seeps at several places between the top and bottom of the bed.

The oil residue found in the seeps is black when exposed at the surface, but in the rocks and in unexposed crevices it is of a dark-brown color.

Development.—Though oil springs must have been seen by prospectors and traders who operated along San Juan River, they seem to have received only casual notice until 1882, when E. L. Goodridge made the first location of a claim. No drilling was done, however, until the fall of 1907, when the first well, Crossing No. 1, was begun. This well encountered oil March 4, 1908, at a depth of 225 feet. It was a gusher, throwing oil to a height of 70 feet above the floor of the derrick, and led to considerable excitement. Other wells followed in rapid succession in 1908 and 1909, but most of them were only prospect holes put down to validate the titles to claims and not with serious intention of determining the oil resources of the field. By the summer of 1910 considerable capital had been enlisted to exploit the field. One standard rig was in operation and others were reported to have been ordered. There were 10 portable deep-well rigs in the area and several more on the way to it. During midsummer active development was somewhat retarded on account of the heat, but in the latter part of August preparations were made to renew operations with greater vigor than before. Reports received from reliable sources during the winter of 1910–11 indicate that the expectation of activity has been fully realized. On February 1, 1911, according to a report by A. L. Raplee, there were 27 drilling rigs in the field and equipment for more on the way. Two oil wells were brought in during the winter, and there was considerable improvement at old wells. A small town had been established near Mexican Hat and the roads and general facilities much improved.

There are several factors which exert an unusual influence in the development of the San Juan field. The area is isolated, and practically all supplies of every kind used in the field must be transported from the railroad by wagon across an almost desert country, where only ungraded roads exist and where travel is insufficient to warrant the proper construction or maintenance of roads. The places to which supplies for the field are shipped by railroad are as follows:

Dolores, Colo.: Rio Grande Western Railway (Denver & Rio Grande System), narrow gage, 106 miles; stage daily.

Mancos, Colo.: Denver & Rio Grande Railroad, about the same distance.

Thompson, Utah: Denver & Rio Grande Railroad, standard gage, 158 miles; stage triweekly.

Farmington, N. Mex.: Denver & Rio Grande Railroad, 110 miles.

Gallup, N. Mex.: Atchison, Topeka & Santa Fe Railway, 175 miles.

Fuel is scarce. There are a few piñon on Cedar Mesa and a scant growth at the base of the escarpment around the mesa, but the accessible wood is rapidly disappearing and there is probably no coal within a reasonable distance. The fuel most commonly used is oil from the producing wells in the field, which is hauled in barrels from the wells to the place where it is consumed. The common price of oil in the field is $1.25 a barrel.

Common labor can be obtained from settlements elsewhere in Utah and in adjacent States. So far as known, there has been no attempt to employ the Navajo Indians, who inhabit the region immediately to the south. These Indians are generally industrious and fairly intelligent. It is believed that their employment may help to settle the labor question so far as unskilled labor is concerned.

Transportation for the oil is requisite before the field can become commercially productive or economically important. A pipe line could be constructed to any one of the railroad points mentioned. At least two lines of railroad into the field have been under consideration, both of which are pronounced practicable by engineers.

These oils, as shown by the analyses, are usually light in specific gravity. They yield more than the average amount of gasoline and of burning oil. The light specific gravity of the burning oil fraction compared to the average, the considerable amount of paraffin wax, and the comparatively low proportion of unsaturated hydrocarbons show that these oils are somewhat similar to the oil from Lima, Ohio, with a smaller proportion of sulphur. In fact, the amount of sulphur is less than in many oils in Illinois, which are refined without special apparatus for eliminating sulphur. Taken altogether, these oils are well suited for the manufacture of gasoline and kerosene, and there is every indication that the residuum would yield valuable lubricating oils.

Chemical and physical properties of oil in the San Juan oil field, Utah.

Serial No. (Utah).		Depth (feet).	Physical properties.		Distillation by Engler's method.								Sulphur (per cent).	Paraffin (per cent).	Asphalt (per cent).	Unsaturated hydrocarbons (per cent).	
			Gravity.		Begins to boil (°C).	By volume.											
						To 150° C.		150°–300° C.		Residuum.		Total cubic centimeters.					
			Specific.	Degrees Baumé.		Cubic centimeters.	Specific gravity.	Cubic centimeters.	Specific gravity.	Cubic centimeters.	Specific gravity.					Crude.	100°–300° C.
4	Well No. 4, Goodridge townsite; E. L. Goodridge, Goodridge [a]	263	0.8264	39.4	70	12.0	0.7245	36.0	0.7941	49.3	0.8974	99.3	0.26	6.09	0.80	20.4	1.0
5	Jackson well, sec. 5, T. 42 S., R. 19 E., stray sand; Monumental Oil Co., Bluff [a]	625	.8314	38.4	78	11.0	.7235	35.0	.7976	51.0	.8946	97.0	.18	5.29	.60	14.8	6.0
6	Anderson well, sec. 5, T. 42 S., R. 19 E., Baby or "Goodridge" sand; South Side Oil Co., Mexican Hat [a]	300	.8202	40.7	73	12.0	.7130	36.0	.7941	49.5	.8975	97.5	.20	3.25	1.11	14.4	8.0
7	Arcola well No. 2, T. 42 S., R. 19 E., Mendenhall sand; Bluff [b]	600	.8388	36.9	97	10.0	.7395	37.0	.8021	52.0	.8986	99.0	.40	6.79	.49	19.2	6.0

[a] Color, black.

[b] Color, dark green.

FIELD REPORT.

The field report for Utah in 1911 is shown in the following table:

Field report for Utah in 1911, by counties.

County.	Wells.					Acreage.		
	Productive Jan. 1.	Completed in 1911.		Abandoned.	Productive Dec. 31.	Fee.	Lease.	Total.
		Oil.	Dry.					
San Pete	2				2	200		200
San Juan	9		7		9	11,700	360	12,060
Washington	6				6	700		700
Total	17		7		17	12,600	360	12,960

MISSOURI.

A small production continues to be made in Missouri, as is shown in the following table:

Production of petroleum in Missouri, 1902–1911, in barrels.

Year.	Quantity.	Year.	Quantity.
1902	[a] 757	1907	[a] 4,000
1903	[a] 3,000	1908	[a] 15,246
1904	[a] 2,572	1909	[a] 5,750
1905	[a] 3,100	1910	[a] 3,615
1906	[a] 3,500	1911	[a] 7,995

[a] Includes the production of Michigan.

ARIZONA.

With no established oil field, to say nothing of actual production, wildcat wells are going down in several Arizona localities—among them being a well 20 miles north of Agua Caliente in the southwest corner of Maricopa County, where no oil has yet rewarded the enterprise. Gas seepages have led to drilling which is not yet complete but has developed considerable gas pressure near Tucson in the Catalina Mountains. West of Fairbank, in the Lost Hills district, a well is drilling with rotary tools. East of Florence, near Winkelman, artesian water has been obtained in a well drilled for oil. Gas pressures are reported in a well which is drilling near Camp Verde, Yavapai County.

NEW MEXICO.

Oil has been found in New Mexico in three well separated fields—(1) the Dayton field in Eddy County; (2) an area south of Raton in Colfax County; and (3) the Seven Lakes field in McKinley County. Of these the Dayton field is the only one that has become a producer and that only to a slight extent for local use as a fuel. To the north, in Chaves County near Artesia, oil has been found recently directly under fresh water, a condition similar to the occurrence to the south at Dayton, except that the oil is about 950 feet below the surface at Dayton and about 1,260 feet at Artesia. The region was described in the report of this series for 1909. The Colfax County locality aroused interest several years ago but has not been developed. In 1909 and 1910 considerable attention was paid to the Seven Lakes field, and several shallow and one or two deep wells were drilled. The region and the geologic conditions governing the accumulation of oil have been described in Bulletins 285 and 316 of the United States Geological Survey. The region has also been visited by geologists of the Atchison, Topeka & Santa Fe Railway and by Thomas H. Galey. From their reports it is evident that the oil land occurs on the southern rim of the great San Juan River basin, which extends from Gallup on the south to Durango, Colo., on the north. The rim of the basin south of Seven Lakes is composed of the Mesaverde formation, which dips gently to the north toward the center of the basin. In the center of the syncline north of Chaco River this formation is covered by younger strata. At Baker's trading post, 18 miles northeast of Gallup, there outcrops a sand which is about 50 feet thick and is impregnated with "live" oil at the bottom. The top of the sand generally contains only enough oil to cause a discoloration, but in some places the amount is so slight that the rock is not even discolored. In some of the water wells bored in the coal field near Gallup some oil has been found. The sand is locally known as the Baker sand. Some 10 or 12 years ago two wells were drilled on top of this sand, one to a depth of 1,200 feet and the other 300 or 400 feet, but the only sand encountered was the Baker sand, which in the deep well was at the surface and in the other well about 60 feet below the surface. In the latter part of 1910 a well was sunk in the valley to a depth of about 1,500 feet and no oil was struck. Owing to the synclinal structure younger formations occur toward the Indian agency, but at the agency 20 miles from Baker's trading post the Mesaverde formation again appears. North from the agency the country slopes gradually to the San Juan River, and other and higher formations begin to appear on top of the Mesaverde. A short distance north of the agency the formation consists of leached bituminous sandstone and shale in thin layers. It is estimated that at Seven Lakes the oil-bearing rock lies from 800 to 1,000 feet below the surface.

Oil was discovered in the Seven Lakes field by George F. Brock, of Gallup, while drilling a well for water in June, 1911. The well is 364 feet deep and is connected with Chaves station of the Santa Fe Railway by 32 miles of good wagon road. Since the discovery of oil about 17 wells have been drilled, 15 of which range from 400 to 800 feet in depth. Two are over 1,000 feet deep. No well sufficiently deep to thoroughly test the field has yet been made. The operations cover about 12 townships. Every odd section of land was granted to the Santa Fe Railway; of the remainder a little has been allotted to the Indians, and the rest is public land. The wells usually have been drilled for the purpose of the required development work and to constitute discoveries of oil. Only one well, the Brock discovery well, has been pumped. Fresh water, which of itself is of great value in this dry region has been found in every well immediately below the oil. Small amounts of natural gas have been noted at various horizons.

ALASKA.

Petroleum seepages have been known for many years on the Alaskan coast for 25 miles east of Copper River delta. The first claims were probably staked out in 1896, and several of these claims form the Alaska Development Co., which leased perhaps 50 locations to the Pacific Oil & Coal Co. That company subleased to the Pacific Mines Co., both of these being Canadian corporations. The Pacific Mines Co. drilled 5 wells near Katalla, in 4 of which oil is reported to have been found. After much litigation the Amalgamated Development Co. bought up the ownership and cleaned out 2 of the wells. In the report of progress of the division of Alaskan mineral resources of the United States Geological Survey it is stated that in 1910 a tank was erected on Kanak Island, Controller Bay, and connected by pipe line with the wells, and a small refinery was erected on Katalla Slough. No use appears to be made of the tank, but in 1911 oil was pumped from the wells and refined, the product being disposed of at Cordova, Valdez, and other local settlements. In August, 1911, this company had erected a new derrick near the producing well and prepared to do some more drilling.

The British Columbia Katalla Oil Co. erected a derrick on Mirror Slough, about 7 miles northwest of Katalla, and in August, 1911, had reached a depth of about 500 feet. Later in the year the Mirror Slough Oil Co. put in a rig near the one mentioned above. It is also reported that further drilling is to be done on Katalla Slough and on Katalla and Martin rivers. The season of 1912, therefore, promises to be one of considerable activity in this field.

This Alaskan oil, analyses of which have appeared in previous volumes of Mineral Resources, is light, practically free from sulphur, and contains a high proportion of gasoline, kerosene, and paraffin wax.

IMPORTS.

The value of the imports for consumption of petroleum is reported by the Bureau of Statistics as follows for the last four years: 1908, $607,658; 1909, $197,023; 1910, $1,398,861; 1911, $2,410,884. The value of the imports for consumption of ozokerite and paraffin for the same period is: 1908, $507,363; 1909, $778,681; 1910, $1,025,829; 1911, $792,818.

EXPORTS.

TERRITORIAL SHIPMENTS.

Alaska.—In the following table are given the shipments of petroleum products to Alaska from 1906 to 1911, inclusive:

Shipments of petroleum products to Alaska from other parts of the United States, 1906–1911, in gallons.

Year.	Crude.		Naphtha.		Illuminating.		Lubricating.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
1906	2,688,100	$38,409	580,978	$100,694	568,033	$109,964	83,992	$32,854
1907	9,104,300	143,506	636,881	119,345	510,145	99,342	100,145	37,929
1908	11,891,375	176,483	939,424	147,104	566,598	102,567	94,542	36,423
1909	14,034,900	334,258	746,930	118,810	531,727	98,786	85,687	35,882
1910	18,835,670	477,673	788,154	136,569	626,972	95,483	104,512	38,625
1911	18,142,364	406,400	1,238,865	167,915	423,750	57,896	100,141	34,048

Hawaiian Islands, Philippine Islands, and Porto Rico.—In the following table are given the shipments of petroleum products to the Hawaiian Islands, Philippine Islands, and Porto Rico from 1906 to 1911, inclusive:

Shipments of petroleum products to Hawaii, the Philippines, and Porto Rico, 1906–1911, in gallons.

Year.	Crude.		Naphtha.		Illuminating.		Lubricating.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
HAWAII.								
1906	38,883,100	$871,830	550,975	$71,954	1,225,864	$199,443	241,567	$76,134
1907	38,916,400	581,905	484,435	73,405	1,441,637	230,968	355,451	104,930
1908	47,719,900	802,325	648,310	91,851	1,143,591	179,507	358,262	140,157
1909	43,461,493	845,805	804,169	127,076	1,401,381	232,340	367,831	121,282
1910	54,117,100	1,061,060	974,268	160,700	1,359,671	226,481	359,528	133,968
1911	46,791,550	917,763	1,329,589	203,052	1,587,873	220,505	466,826	138,927
PHILIPPINES.								
1906	7,360	442	40,450	6,482	4,412,398	398,706	195,006	39,887
1907	....	....	79,560	12,930	8,218,400	842,111	181,504	32,598
1908	4,594	322	140,550	21,775	9,234,263	957,284	257,800	61,571
1909	15,489	1,014	184,390	23,428	5,995,090	558,642	362,068	81,278
1910	13,453	1,098	318,070	42,058	10,643,804	862,496	432,867	95,213
1911	5,502	376	1,074,615	158,592	11,653,570	913,760	470,832	107,499
PORTO RICO.								
1906	16,585	1,224	79,841	17,766	1,315,589	151,013	196,732	41,777
1907	....	....	219,691	38,003	1,700,838	176,808	223,389	53,599
1908	24,937	2,100	285,188	45,479	1,623,477	189,021	264,012	65,776
1909	5,089	340	495,367	93,649	1,931,676	216,316	218,829	78,963
1910	8,739	499	874,814	135,290	1,973,369	222,108	283,935	91,356
1911	51,656	2,899	1,106,327	133,470	2,323,401	207,804	479,579	117,034

FOREIGN EXPORTS.

The following tables, compiled by the Bureau of Statistics of the Department of Commerce and Labor, show the quantity and value of petroleum and its products (mineral oils) exported from ports and districts in the United States for the years ending December 31, 1910 and 1911.

Exports of mineral oils from the United States in the calendar years 1910 ana 1911, by kind and port, in gallons.

Kind and port.	1910		1911	
	Quantity.	Value.	Quantity.	Value.
CRUDE.				
New York	36,111,722	$1,887,411	49,696,542	$2,558,133
Philadelphia	4,468,057	345,279	2,791,450	153,739
Galveston	1,910,483	48,051	726	44
Other districts	137,620,904	3,123,512	149,354,637	3,453,487
Total	180,111,166	5,404,253	201,843,355	6,165,403
NAPHTHA.				
Baltimore	37,500	8,151	24,562	2,258
Boston and Charlestown	39,426	5,430	32,471	3,935
New York	55,655,027	4,877,905	80,101,637	7,149,702
Philadelphia	20,862,392	1,399,866	25,879,405	1,678,741
Galveston	45	9	39,241	5,137
Other districts	24,100,992	2,115,741	31,217,290	2,642,988
Total	100,695,382	8,407,102	137,294,606	11,482,761

Exports of mineral oils from the United States in the calendar years 1910 and 1911, by kind and port, in gallons—Continued.

Kind and port.	1910.		1911.	
	Quantity.	Value.	Quantity.	Value.
ILLUMINATING.				
Baltimore	6,943,273	$360,707	4,070,201	$216,785
Boston and Charlestown	129.906	13.366	201,169	17,085
New York	575,978.402	37.530.408	650,810,744	38,913,023
Philadelphia	266,969,325	13,460,502	286,945,777	14,127,603
Galveston	352	67	735,400	40,484
Other districts	90.225,781	4,277,318	169,531,715	7,740,115
Total	940,247,039	55,642,368	1,112,295,006	61,055,095
LUBRICATING AND PARAFFIN.				
Baltimore	6,037,623	861,290	7,334,394	925,839
Boston and Charlestown	199,499	37,624	132,350	29,103
New York	100,415,326	13,937,383	115,003,462	15,942,060
Philadelphia	50,419,517	4,861,179	53,319,637	5,124,507
Galveston	943,877	191,275	784,215	152,488
Other districts	5,816,702	1,032,352	6,745,587	1,163,129
Total	163,832,544	20,921,103	183,319,645	23,337,126
RESIDUUM.				
Boston and Charlestown	63,600	2,549	150,000	4,677
New York	22,347,546	654,171	40,036,883	1,209,180
Philadelphia	24,257,035	718,568	24,781,953	647,124
Galveston			29,640	1,593
Other districts	70,937,621	2,356,908	68,980,611	2,019,889
Total	117,605.802	3,732,196	133,979,087	3,882,463
Grand total	1,502,491,933	94,107,022	1,768,731,699	105,922,848

RECAPITULATION BY KINDS, IN GALLONS.

Crude	180,111,166	$5,404,253	201,843.355	$6,165,403
Naphtha	100.695,382	8,407,102	137,294,606	11,482,761
Illuminating	940,247,039	55,642,368	1,112,295,006	61,055,095
Lubricating and paraffin	163,832.544	20.921,103	183,319,645	23,337,126
Residuum	117,605,802	3,732,196	133,979,087	3,882,463
Total	1,502,491,933	94,107,022	1,768,731,699	105,922,848

RECAPITULATION BY PORTS, IN GALLONS.

Baltimore	13,018.396	$1,230,148	11,429,157	$1,144,882
Boston and Charlestown	432,431	58.969	515,990	54,800
New York	790,508,023	58,887,278	935,649,268	65,772,098
Philadelphia	366.976.326	20,785,394	393,718.222	21,731,714
Galveston	2,854,757	239,402	1,589,222	199,746
Other districts	328,702,000	12,905,831	425,829,840	17,019,608
Total	1,502,491,933	94,107,022	1,768,731,699	105,922,848

Exports of mineral oils from the United States in 1910 and 1911, by months, in gallons.

Month.	1910		1911	
	Quantity.	Value.	Quantity.	Value.
January	100,607,894	$6,692,137	109,437,912	$6,419,647
February	103,894,100	6,517,972	121,980,429	7,408,493
March	132,894,466	8,369,396	153,405,159	9,212,258
April	124,145,014	7,764,874	154,214,494	9,010,533
May	139,645,121	8,728,503	150,629,691	9,249,122
June	131,664,396	8,537,394	157,232,119	9,318,717
July	123,078,112	7,894,528	170,863,408	9,594,307
August	142,209,938	9,045,686	161,404,093	9,778,537
September	127,982,115	8,118,525	169,055,076	9,980,626
October	126,611,839	7,763,115	154,715,980	9,440,291
November	128,949,683	7,371,705	127,260,425	8,007,664
December	120,809,255	7,303,187	138,532,913	8,502,653
Total	1,502,491,933	94,107,022	1,768,731,699	105,922,848

The following table exhibits the total production of petroleum from 1902 to 1911, in barrels and in gallons, also the separate derivatives exported and their value, together with their sum and value:

Quantity of petroleum produced in, and quantities and values of petroleum products exported from, the United States during each of the calendar years from 1902 to 1911, inclusive, in gallons.

Year.	Production.		Exports.			
					Mineral, refined or manufactured.	
	Barrels of 42 gallons.	Gallons.	Mineral, crude (including all natural oils, without regard to gravity).		Naphtha, benzine, gasoline etc.	
			Quantity.	*Value.*	*Quantity.*	*Value.*
902	88,766,916	3,728,210,472	145,233,723	$6,331,011	19,682,637	$1,392,771
903	100,461,337	4,219,376,154	126,511,687	6,782,136	12,973,153	1,518,541
904	117,080,960	4,917,400,320	111,176,476	6,350,682	24,989,422	2,321,714
905	134,717,580	5,658,138,360	126,185,187	6,085,592	28,419,930	2,214,609
906	126,493,936	5,312,745,312	148,045,315	7,731,226	27,544,939	2,488,401
907	166,095,335	6,976,004,070	126,306,549	6,333,715	34,625,525	3,676,206
908	178,527,355	7,498,148,910	149,190,017	6,519,849	43,887,044	4,542,551
909	183,170,874	7,693,176,708	170,337,773	6,027,588	68,758,675	5,799,994
910	209,559,248	8,801,404,416	180,111,166	5,404,253	100,695,382	8,407,102
911	220,449,391	9,258,874,422	201,843,355	6,165,403	137,294,606	11,482,761

Year.	Exports.				Exports.			
	Mineral, refined or manufactured.				Residuum (tar, pitch, and all other, from which the light bodies have been distilled).		Total exports.	
	Illuminating.		Lubricating (heavy paraffin, etc.).					
	Quantity.	*Value.*	*Quantity.*	*Value.*	*Quantity.*	*Value.*	*Quantity.*	*Value.*
902	778,800,978	$49,079,055	82,200,503	$10,872,154	38,315,760	$922,152	1,064,233,601	$68,597,143
903	691,837,234	51,355,668	95,621,941	12,690,065	9,753,240	282,129	936,697,255	72,628,539
904	761,358,155	58,384,273	89,688,123	12,393,382	34,904,100	1,174,156	1,022,116,276	80,624,207
905	881,450,388	54,900,649	113,730,205	14,312,383	70,727,877	2,127,696	1,220,513,587	79,640,929
906	878,274,104	54,858,312	151,268,522	18,689,622	64,644,765	1,971,305	1,269,777,645	85,738,866
907	905,924,296	59,635,208	152,028,855	19,210,353	75,774,754	2,527,582	1,294,659,979	91,383,064
908	1,129,004,833	75,988,256	147,769,024	18,971,436	77,551,683	2,793,363	1,547,402,601	108,815,455
909	1,046,401,072	67,814,406	161,639,609	20,016,107	121,966,249	4,180,495	1,569,103,378	103,838,590
910	940,247,039	55,642,368	163,832,544	20,921,103	117,605,802	3,732,196	1,502,491,933	94,107,022
911	1,112,295,006	61,055,095	183,319,645	23,337,126	133,979,087	3,882,463	1,768,731,699	105,922,848

Exports of domestic petroleum from Pacific ports during the calendar years 1909, 1910, and 1911 were as follows:

Exports of petroleum from Pacific ports in 1909, 1910, and 1911, in gallons.

Customs district.	1909		1910		1911	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
From—						
Alaska					660	$66
Los Angeles	18,170,000	$346,300	7,833,000	$141,260	4,284,000	86,850
Puget Sound	3,488,034	72,098	6,113,526	147,652	15,280,832	374,318
San Diego	27,580	812	333,609	7,335	590,372	11,451
San Francisco	83,934,734	1,495,508	127,470,032	2,310,516	121,073,965	2,110,692
Total	105,620,348	1,914,718	141,750,167	2,606,763	141,229,829	2,583,377
To—						
Alaska	14,034,900	334,258	18,835,670	477,673	18,142,364	406,400
Canada	3,828,934	79,506	5,841,856	140,679	15,411,205	373,114
Chile	17,809,500	268,535	20,630,499	295,072	19,454,000	292,200
Guatemala	1,050,000	15,000	4,872,000	69,600	1,092,000	15,600
Hawaii	43,461,493	845,805	54,117,100	1,061,060	46,791,550	917,763
Japan						
Mexico	27,580	812	333,609	7,335	590,592	11,467
Panama	23,882,500	339,150	32,592,000	465,600	36,734,880	524,784
Peru	1,516,349	30,690	4,524,133	89,645	3,000,329	41,367
Salvador	1,650	50	1,100	33	4,655	240
Other	7,442	912	2,200	66	8,254	442
Total	105,620,348	1,914,718	141,750,167	2,606,763	141,229,829	2,583,377

FOREIGN MARKETS.

In the following table is given a statement showing the foreign markets for oil in the four fiscal years ending June 30, 1911:

Exports of petroleum in its various forms from the United States for the fiscal years 1908 to 1911, by countries and kinds, in gallons.

Country and kind.	Year ending June 30—			
	1908	1909	1910	1911
CRUDE.				
Europe:				
Belgium	52	201,107	104	
France	40,555,219	33,168,985	13,087,508	21,843,88
Germany	6,485,413			17,50
Spain	9,526,563	10,038,730	9,691,256	11,616,69
United Kingdom	8,934,223	24,590,204		22
Other Europe	2,470	511		
	65,503,940	67,999,537	22,778,868	33,478,29
North America:				
Mexico	17,523,440	27,554,581	41,202,786	24,398,33
Cuba	5,040,720	5,493,314	4,713,586	5,228,40
Dominion of Canada	28,577,508	35,366,004	39,222,019	52,260,86
Panama	5,562,745	13,250,620	26,597,900	38,958,00
Other North America	906,405	1,899,204	4,004,453	3,052,58
	57,610,818	83,563,723	115,740,744	123,898,18
South America	3,365,728	10,182,832	30,353,669	27,794,09
Japan	8,742,789	8,102,423		
All other countries	300	6,794	30,704	20,18
Total crude	135,223,575	169,855,309	168,903,985	185,190,76

Exports of petroleum in its various forms from the United States for the fiscal years 1908 to 1911, by countries and kinds, in gallons—Continued.

Country and kind.	Year ending June 30—			
	1908	1909	1910	1911
REFINED.				
Naphtha.				
Europe:				
France	10,485,796	23,553,067	6,583,437	8,570,396
Germany	2,074	750,000	11,394,253	7,668,059
Sweden	1,267,611	378.558	522,680	702,010
United Kingdom	6,843,892	16,148,285	16,924,159	28,332,440
Other Europe	2,701,661	4,623,663	12,419,372	20,487,537
	21,301,034	45,453,573	47,843,901	65,760,442
North America	7,994,179	8,704,588	17,320,657	24,173,133
West Indies	132.171	310,241	320,160	539,065
South America	2,499,971	3,690,656	5,785,161	11,047,387
Asia and Oceania	3,588,315	4,602,975	5,210,862	8,339,291
Africa	726,700	1,069,234	1,170,182	2,138,942
	14,941.336	18,377.694	29,807,022	46,237,818
Total naphtha	36,242,370	63,831,267	77,650,923	111,998,260
Illuminating.				
Europe:				
Belgium	48,597,412	54,429,995	41,287,412	51,194,876
Denmark	17,873,509	20,985,608	20,238,497	23,494,756
France	52,752,810	64,534,115	46,924,343	45,322,937
Germany	151,802,286	131,299,633	151,890,625	106,405,766
Italy	22,926,445	23,355,053	26,057,918	23,915,541
Netherlands	126,335,611	134,656,827	121,808,987	102,904,032
Sweden and Norway	37,738,705	43,186,026	37,187,417	43,055,097
United Kingdom	206,875,262	223,313,293	194,226,610	164,599,861
Portugal	7,759,171	5,999,563	5,751,226	3,958,728
Other Europe	4,002,069	3,182,583	4,191,054	3,952,915
	676,663,280	704,942,696	649,564,089	568,804,509
North America:				
British North America	6,196,631	13,824,783	10,201,902	11,257,460
Central America	2,424,129	2,317,303	2,590,238	3,413,245
Mexico	764,067	511,276	740,615	200,252
West Indies—				
British	2,777,266	2,859,903	3,002,377	3,164,058
Other	2,885,350	2,143,867	3,447,741	4,031,921
Other North America	653,375	683,574	669,073	836,597
	15,700.818	22,340,706	20,651,946	22,903,533
South America:				
Argentina	18,532,187	16,384,837	18,490,512	15,723,182
Brazil	24,359,423	27,999,696	29,874,870	30,846,695
Chile	6,250,448	8,264,431	8,059,982	7,123,137
Uruguay	5,158,182	5,154,920	7,009,158	6,140,675
Venezuela	1,207,665	1,372,075	1,444,847	1,449,897
Other South America	3,557,761	3,503,333	3,546,848	3,270,171
	59,065,666	62,679,292	68,426,217	64,553,757
Asia:				
Chinese Empire	103,737,770	87,006,468	65,817,980	107,167,449
Honkong	11,107,670	10,370,460	12,692,037	12,074,776
East Indies—				
British	39,173,434	42,949,022	37,545,823	51,735,360
Dutch	11,786,410	16,140,190	12,572,121	19,235,260
Other East Indies	5,331,150	8,757,552	4,707,640	6,185,050
Japan	60,540,424	67,707,658	58,067,925	57,750,354
Other Asia	7,973,490	5,610,450	11,596,113	19,887,195
	239,650,348	238,541,800	202,999,639	274,035,444
Oceania:				
British	22,129,147	26,776,574	26,452,025	29,478,944
Philippine Islands	10,097,393	8,997,610	6,265,167	9,887,437
Other Oceania	1,230	930	10,880	17,084
	32,227,770	35,775,114	32,728,072	39,383,465
British Africa	10,966,114	8,484,285	18,135,570	16,604,729
Other Africa	7,451,905	7,778,563	12,522,003	36,025,605
	18,418,019	16,262,848	30,657,573	52,630,334
Total illuminating	1,041,725,901	1,080,542,456	1,005,027,536	1,022,311,042

Exports of petroleum in its various forms from the United States for the fiscal years 1908 to 1911, by countries and kinds, in gallons—Continued.

Country and kind.	Year ending June 30—			
	1908	1909	1910	1911
REFINED—continued.				
Lubricating.				
Europe:				
Belgium	9,706,311	9,853,648	10,671,107	10,229,815
France	19,943,853	18,581,934	20,653,620	19,449,734
Germany	22,158,084	19,708,146	20,533,022	20,450,031
Italy	5,845,997	7,656,884	7,606,839	8,323,598
Netherlands	9,650,719	8,372,364	9,571,203	10,488,285
United Kingdom	50,427,085	42,000,598	54,748,608	53,573,129
Other Europe	6,936,297	6,868,299	7,986,759	9,026,568
	124,668,346	113,041,873	131,771,158	131,541,160
North America	4,287,590	4,537,812	6,095,575	7,064,255
West Indies	1,240,239	1,278,500	1,380,979	1,505,270
South America	6,057,608	6,742,209	7,494,903	7,843,115
Asia and Oceania	20,203,987	15,583,310	17,047,643	18,752,639
Africa	3,306,130	3,070,567	6,640,019	6,936,056
	35,095,554	31,212,398	38,659,119	42,101,335
Total lubricating	159,763,900	144,254,271	170,430,277	173,642,495
Residuum (barrels).				
Europe	65,979,758	92,070,389	112,792,362	102,430,883
North America	4,467,937	10,962,529	10,742,492	15,708,381
All other countries	134,127	155,115	520,409	5,258,924
Total residuum	70,581,822	103,188,033	124,055,263	123,398,188

PRICES.

In the following tables the prices per gallon of refined oils of 70° Abel test are given:

Weekly prices of refined petroleum in the United States in 1911, at New York, in cents per gallon.

Week ending—	Refined oil.			Week ending—	Refined oil.		
	Bulk.	Cases.	Barrels.		Bulk.	Cases.	Barrels.
Jan. 7	3.90	8.90	7.40	Aug. 5	3.75	8.75	7.25
14	3.90	8.90	7.40	12	3.75	8.75	7.25
21	3.90	8.90	7.40	19	3.75	8.75	7.25
28	3.90	8.90	7.40	26	3.75	8.75	7.25
Feb. 4	3.90	8.90	7.40	Sept. 2	3.75	8.75	7.25
11	3.90	8.90	7.40	9	3.75	8.75	7.25
18	3.90	8.90	7.40	16	3.85	8.85	7.35
25	3.90	8.90	7.40	23	3.85	8.85	7.35
Mar. 4	3.90	8.90	7.40	30	3.85	8.85	7.35
11	3.90	8.90	7.40	Oct. 7	3.85	8.85	7.35
18	3.90	8.90	7.40	14	3.85	8.85	7.35
25	3.90	8.90	7.40	21	3.85	8.85	7.35
Apr. 1	3.90	8.90	7.40	28	3.85	8.85	7.35
8	3.90	8.90	7.40	Nov. 4	3.85	8.85	7.35
15	3.90	8.90	7.40	11	3.85	8.85	7.35
22	3.90	8.90	7.40	18	3.85	8.85	7.35
29	3.75	8.75	7.25	25	3.85	8.85	7.35
May 6	3.75	8.75	7.25	Dec. 2	3.85	8.85	7.35
13	3.75	8.75	7.25	9	3.85	8.85	7.35
20	3.75	8.75	7.25	16	3.85	8.85	7.35
27	3.75	8.75	7.25	23	3.85	8.85	7.35
June 3	3.75	8.75	7.25	30	3.85	8.85	7.35
10	3.75	8.75	7.25				
17	3.75	8.75	7.25				
24	3.75	8.75	7.25				
July 1	3.75	8.75	7.25				
8	3.75	8.75	7.25				
15	3.75	8.75	7.25				
22	3.75	8.75	7.25				
29	3.75	8.75	7.25				

Wholesale prices of refined petroleum at New York at the first of each month, 1907–1911.

Month.	1907			1908			1909			1910			1911		
		Cents per gallon.			Cents per gallon.			Cents per gallon.			Cents per gallon.			Cents per gallon.	
	Date.	In barrels.	In cases.	Date.	In barrels.	In cases.	Date.	In barrels.	In cases.	Date.	In barrels.	In cases.	Date.	In barrels.	In cases.
January	5	7.50	10.00	4	8.75	10.90	2	8.50	10.90	1	8.05	10.45	7	7.40	8.90
February	2	7.75	10.25	1	8.75	10.90	6	8.50	10.90	5	7.90	10.30	4	7.40	8.90
March	2	7.75	10.25	7	8.75	10.90	6	8.50	10.90	5	7.90	10.30	4	7.40	8.90
April	6	8.20	10.65	4	8.75	10.90	3	8.50	10.90	2	7.90	10.30	1	7.40	8.90
May	4	8.20	10.65	2	8.75	10.90	1	8.50	10.90	7	7.75	10.15	6	7.25	8.75
June	1	8.20	10.65	6	8.75	10.90	5	8.50	10.90	4	7.75	10.15	3	7.25	8.75
July	6	8.45	10.90	4	8.75	10.90	3	8.40	10.80	2	7.65	10.05	1	7.25	8.75
August	3	8.45	10.90	1	8.75	10.90	7	8.25	10.65	6	7.65	10.05	5	7.25	8.75
September	7	8.45	10.90	5	8.75	10.90	4	8.25	10.65	3	7.50	9.90	2	7.25	8.75
October	5	8.45	10.90	3	8.50	10.90	2	8.25	10.65	1	7.50	9.90	7	7.35	8.85
November	2	8.75	10.90	7	8.50	10.90	6	8.15	10.55	5	7.40	8.90	4	7.35	8.85
December	7	8.75	10.90	5	8.50	10.90	4	8.05	10.45	3	7.40	8.90	2	7.35	8.85

Monthly average prices, in cents per gallon, of petroleum exported from the United States in bulk, 1908–1911.

Month.	1908		1909		1910		1911	
	Crude.	Refined, illuminating.	Crude.	Refined, illuminating.	Crude.	Refined, illuminating.	Crude.	Refined, illuminating.
January	4.9	6.5	3.4	6.5	2.9	6.5	3.1	5.3
February	4.7	6.4	4.6	6.7	2.7	6.0	3.5	5.3
March	5.4	7.1	3.9	6.5	2.7	5.9	2.4	5.6
April	4.5	7.2	3.7	6.8	3.4	6.1	2.8	5.5
May	3.3	7.3	4.9	7.1	3.0	6.1	2.8	5.6
June	5.6	6.8	3.4	6.3	3.6	6.0	3.1	5.4
July	4.6	7.0	2.6	6.5	2.5	6.3	2.8	5.4
August	3.8	6.8	3.9	6.1	2.3	6.1	3.2	5.6
September	4.3	6.7	3.5	6.4	3.4	5.9	2.4	5.4
October	4.9	6.1	2.9	6.2	3.0	5.7	3.6	5.5
November	3.8	6.6	2.9	6.3	3.2	5.0	3.9	5.7
December	3.6	6.4	3.1	6.5	2.9	5.5	3.2	5.4

FOREIGN OIL FIELDS.

CANADA.

Production.—In the following table is given the total production of petroleum in Canada from 1902 to 1911, inclusive, as reported by the Geological Survey of Canada:

Production of petroleum in Canada, 1902–1911.

Year.	Quantity.	Value.	Average price per barrel.
	Barrels.[a]		
1902	530,624	$951,190	$1.79¼
1903	486,637	1,048,974	2.15½
1904	552,575	984,310	1.78
1905	634,095	856,028	1.35
1906	569,753	761,760	1.33[illegible]
1907	788,872	1,057,088	1.34
1908	527,987	747,102	1.41½
1909	420,755	559,604	1.33
1910	315,895	388.550	1.23
1911	291,096	357,073	1.22⅔

[a] Barrels of 35 imperial gallons.

Production of petroleum in Ontario and New Brunswick in 1909, 1910, and 1911, by districts, in barrels.

District.	1909	1910	1911
Bothwell	38,092	36,998	35,244
Dutton	9,513	7,752	6,732
Lambton	243,123	205,456	184,450
Leamington	5,929	141	13,501
Onondaga (Brant County)	....	1,005	
Tilbury and Romney	124,003	63,058	48,708
Total Ontario	420,660	314,410	288,635
New Brunswick	95	1,485	2,461
Total Canada	420,755	315,895	291,096

Production of petroleum in Ontario, Canada, 1902–1911, by districts, in barrels of 35 imperial gallons.

District.	1902	1903	1904	1905	1906	1907	1908	1909	1910	1911
Bothwell	50,141	48,880	47,654	47,959	43,836	40,556	39,820	38,707	36,615	35,094
Coatsworth (Romney)	......	......	......	......	......	49,784	11,165	1,082	......	......
Dutton	8,867	21,483	14,217	20,976	18,597	14,698	12,268	10,052	7,860	3,59
Leamington	......	1,190	25,241	113,806	35,958	16,210	18,117	9,367	248	.....
Blytheswood	......	......	669	......						
Comber	......	......	97	......						
Staples	......	......	......	......						
East Tilbury	......	......	......	......	115,400	344,358	170,589	115,862	60,416	49,02
Raleigh, including Pardo's Siding and Sandison	2,462	1,161	3,274	......						
Moore Township	......	......	36,971	93,815	53,030	32,720	25,667	18,033	14,614	......
Onondaga	......	......	......	......	......	......	......	......	1,070	12,60
Oil Springs	60,747	56,405	75,530	78,125	68,100	55,813	61,252	60,868	55,508	56,24
Pelee Island	......	......	1,023	......	......	......	......	......	......	......
Richardson Station (Chatham), including Blakely	......	......	......	1,249	1,376	940	2,883	2,923	1,689	1,77
Thamesville	......	......	5,027	2,463	1,585	1,139	853	710	141	......
Wheatley	......	1,995	4,490	1,750	......	......	......	......	......	......
Petrolia and all other districts	397,628	350,390	278,299	250,701	247,446	206,285	171,019	156,581	129,372	126,08
Total	519,845	481,504	492,492	610,844	585,328	762,503	513,633	414,185	307,533	284,43

Prices.—The average monthly prices per barrel from 1907 to 1911 inclusive, are given in the following table:

Average monthly prices per barrel for crude oil at Petrolia, 1907–1911.

Month.	1907	1908	1909	1910	1911	Month.	1907	1908	1909	1910	191
January	$1.34	$1.34	$1.44	$1.24	$1.22	August	$1.38	$1.44	$1.26	$1.22	$1.
February	1.35	1.34	1.44	1.24	1.22	September	1.38	1.44	1.26	1.22	1.
March	1.37	1.34	1.44	1.24	1.22	October	1.38	1.44	1.25	1.22	1.
April	1.38	1.44	1.44	1.24	1.22	November	1.38	1.44	1.24	1.22	1.
May	1.38	1.44	1.36	1.24	1.22	December	1.38	1.44	1.24	1.22	1.
June	1.38	1.44	1.33	1.22	1.22						
July	1.37	1.44	1.27	1.22	1.22	The year	1.37	1.41½	1.33	[a]1.23	1.2

[a] Price of oil changed June 11 from $1.24 to $1.22.

MEXICO.

Development.—The stimulus given to the Mexican oil trade by th development of the great Potrero del Llano and Juan Casiana o wells at the close of 1910 turned the energy of the large compani from the pursuit of petroleum pools to the work of marketing a pro uct embarrassingly large.

The productive oil regions described in the report of this series for 1910 were also the dominant ones in 1911. Oil companies by the score sought and obtained land holdings during the year 1911 and their operations will be factors of the succeeding annual period. But in 1911 two great producers controlled the situation: One was the Pearson interest, the "Compañía Mexicana de Petróleo El Águila," with the greatest oil well ever drilled in the world—north of Tuxpan—and its refining plant at Minititlan, the two connected by an efficient transportation system, a pipe line to Tuxpan, where, from a floating loading pipe in the open roadstead the oil is barged to the refinery. With another system of pipe line and barges to the storage system at Tampico and with satisfactory sales arrangements abroad, the deliveries were limited simply by tank-steamer capacity. The other great producer includes the Mexican Petroleum Co., with wells at Ebano, and the Huasteca Petroleum Co. These constitute the Doheny interests. By the exercise of great energy this company had completed a pipe line by the end of 1910 which extended from its Juan Casiana well, north of Tuxpan, along the side of Tamiahua lagoon and the canal system to Tampico, where 100 of the largest practicable steel storage tanks were built with remarkable rapidity. Here, again, the sales were so limited by shipping facilities that stocks at delivery points equaled the capacity.

In addition to these large producers, the productive stage was reached by the Waters-Pierce Oil Co. with wells in the Topila district between Tampico and the old Ebano field, by the East Coast Oil Co. with a considerable production at Topila and Panuco, and by several smaller companies in the same regions.

The results of these operations are shown in the following tables.

New exploratory work, outside of the region north of Tuxpan referred to, was chiefly directed to Valles, Topila, and Panuco. A beginning of development work in the north was made at Soto la Marina; this was stimulated by the projected railroad south from Brownsville, Tex.

Consul C. A. Miller reports that on May 20, 1911, an American tank steamer cleared from Tampico with the first cargo of crude oil. During the rest of the year 39 tank steamers cleared with oil, making the total exports of crude 806,916 barrels. He reports that the rail shipments amounted to 5,000,000 barrels. Several new tank steamers are building for the Mexican trade.

Lower California.—Consul George B. Schmucker, at Ensenada, reports that indications of petroleum have been found near San Miguel, 30 miles north of Ensenada, and at Punta Bonda, a few miles south. Land has been leased near San Miguel by several persons with a view to drilling for oil.

Production.—The best available estimate of the production of petroleum in Mexico from 1907 to 1911 is as follows:

Production of petroleum in Mexico, 1907–1911.

907	barrels	1,000,000
908	do	3,481,410
909	do	2,488,742
910	do	3,332,807
911	do	14,051,643

The following table shows the quantity of crude petroleum, naphtha, and illuminating oil imported from the United States into Mexic in 1909, 1910, and 1911:

Imports of petroleum and specified products into Mexico from the United States, yea ending June 30, 1909, 1910, and 1911.

Kind of oil.	1909		1910		1911	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Gallons.		*Gallons.*		*Gallons.*	
Crude	27,554,581	$1,184,398	41,202,786	$1,428,632	24,398,337	$814,2
Naphtha	73,819	11,417	61,550	8,246	363,101	41,8
Illuminating	511,276	69,224	740,615	76,952	200,252	26,7
Lubricating	1,165,272	214,457	1,376,321	263,599	1,308,964	253,6
Total	29,304,948	1,479,496	43,381,272	1,777,429	26,270,654	1,136,5

Quantity and value of mineral oils imported into Mexico from the United State 1902–1911.

Year ending June 30—	Mineral.					
	Crude.		Refined, including residuum.		Total.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Gallons.		*Gallons.*		*Gallons.*	
1902	10,844,913	$550,694	1,224,589	$209,508	12,069,502	$760,
1903	9,859,154	559,332	1,153,015	218,272	11,012,169	777,
1904	10,938,448	663,575	1,179,894	222,005	12,118,342	885,
1905	14,036,517	786,613	1,216,421	224,061	15,252,938	1,010,
1906	14,366,495	766,353	3,295,325	616,479	17,661,820	1,382,
1907	19,992,434	1,037,226	3,906,472	511,990	23,898,906	1,549,
1908	17,523,440	901,115	1,839,803	320,235	19,363,243	1,221,
1909	27,554,581	1,184,398	1,979,093	306,579	29,533,674	1,490,
1910	41,202,786	1,428,632	2,333,558	357,258	43,536,344	1,785,
1911	24,398,337	814,298	2,895,876	349,787	27,294,213	1,164,

TRINIDAD.

The oil fields of Trinidad are being developed, according to a port from United States Consul Hale, at Port of Spain. The Tri dad Oil Fields Co. struck oil in abundance at a depth of 1,500 fe their well No. 4 yielding, as estimated, 3,000 barrels in 24 hou At La Brea, well No. 8 has found oil at the average depth of 800 fe A refining plant will soon be in operation. Besides the two steel tar with a capacity of 130,000 barrels erected in 1910 and a large ea reserve storage, this company is erecting a number of steel tanks 10,000 to 20,000 barrels capacity each. Rough roads are being c structed through the forests and swamps for transporting machin and material for well drilling in the exploration of properties in interior, and on the southern coast machinery and material val at many thousands of dollars are being landed at great risk and c by companies operating in that district.

The oil fields are about 8 miles inland from Port of Spain, i miasmatic jungle region. About a dozen English companies operating or getting ready to operate the territory. The two c panies that up to this time have made the most progress in development work are the Trinidad Oil Fields (Ltd.) and the Asphalt Lake Co. The first named drilled in a well and at a depth of 1,500 feet produced from 500 to 1,000 barrels a day. This is the well that was mentioned in the consular reports as good for 3,000 barrels a day. This was the first well, however, to get oil on the island at a lower depth than 1,000 feet. This company has completed six or eight wells on its property, ranging from 500 to 1,000 feet in depth.

The Asphalt Lake Co. is the most active in development work and in building up the industry. More than a year ago this company completed a well at a depth of 800 feet. It has quite a number of good wells completed and shut in.

The product is of low grade. It is all of an asphalt base, and its principal commercial value will be for fuel purposes.

Some of the companies have very large concessions. Recently there has been a movement started by the British Government, with which the Government of Trinidad is in full sympathy, to restrict the size of concessions of land for oil prospecting. Should the policy be adopted it would likely expedite the development of the island's petroleum resources.

The conditions of the occurrence of oil and the enterprises engaged in its production were described in the report of this series for 1910. The additional developments seem to show unusual difficulties in exploiting the field owing chiefly to the fact that the oil-bearing sand is very fine grained. The sand frequently rises in the well ("heaves") to such an extent and so rapidly as to choke a producing well, even when the well is of large productive capacity and provided with a good strainer. It seems that the sand is not only fine but unusually uniform in size. When the grains vary in size the finer escape through the strainer and leave the larger grains to form a thicker and thicker sieve on the outside of the strainer, which sieve thus gradually holds back the fine material. But lacking this variation in size of grains, the Trinidad sands have proved difficult to deal with. Thus on November 8, 1911, a very large gusher was struck but it clogged itself in less than four hours.

PERU.

DEVELOPMENT.

A monthly publication of Lima, called Peru To-Day, published recently a valuable article by F. E. Ross, on the petroleum industry in that Republic, which extends the descriptions of the oil resources of Peru that have been published in previous volumes of Mineral Resources.

Petroleum, which occurs in the three northern districts of Tumbes, Pira, and Lambayeque, is found, according to this article, mainly on or near the coast, and often at a shallow depth, although recent drilling shows its presence in large quantities in a lower sand which had previously been exploited.

The first mention of oil in Peru appears in the writings of Padre Acosta, who states that the captain of the ship in which he was sailing detected the presence of land by the oily appearance of the water off Cabo Blanco. It was not until 1692, however, that the matter attracted official attention, and the Spanish Crown ceded the entir petroleum territory to Capt. Grandino. By 1705 this property ha come into the possession of the Belen Hospital, of Piura, but by 182 the Peruvian Government must have recovered the title, for at tha time it sold it to Señor Quintana, who, in turn, sold it the next yea to Señor Diego de Lama. The latter eventually divided it into 1 portions among his children. One of these fractions, covering th ranch of Parinas and La Brea, became the property of Herbe Tweddle in 1888, from whom it was acquired a year later by th London & Pacific Petroleum Co.

In 1910 shipments of Peruvian benzine were made for the firs time to California by the London & Pacific Petroleum Co. in regula tank steamers, which brought back California oil, which is refined i Peru, the gasoline, benzine, and kerosene being sold there and i Chile, and the residue sold also in Peru or Chile as fuel oil. There a already two oil refineries in Peru, producing kerosene, gasolin benzine, and lubricants of fine quality. One of these refineries ha a capacity of 150,000 gallons per month at the end of 1910, a recent additions to the plant will give it a capacity of 200,000 gallo monthly.

Negritos field.—The field known as Negritos or Talara lies about miles along the coast northwest of Paita, the port for the district Piura, and is the center of drilling operations. Talara, an excelle harbor connected with it by 16 miles of narrow-gauge railway, is t location of the refinery and shipping wharves. The residue, aft distillation of the volatile oils, finds a ready market as fuel, and f some time has been shipped to Chile, where it is consumed in t nitrate "oficinas." Besides the oil from the wells scattered throug out the Negritos or ocean side of the property, a black and extreme adhesive material of an asphaltum nature is found at La Brea, so 25 miles inland. This has heretofore been evaporated and used f coating the inside of aguardiente tubs and for weather-proofing t company's piping, etc., but in its natural state it is said to poss good lubricating qualities. The London & Pacific Petroleum Co. pumping 297 wells.

Zorritos field.—This field lies some 24 miles to the south of Tum and is the most northern of the developed properties in Peru. It also on the ocean port. The existence of petroleum in the Zorri field was discovered by De Lama in 1862 and the history of exploitation is a history of repeated financial failures on the part of early promoters, mainly because they failed to provide suffici capital. The present owners, the Peruvian firm of Faustino Piaggio & Co., have, however, fared much better. There are to- some 50 producing wells, including 3 flowing wells in a recen discovered deep sand, a complete distilling and refining plant w iron and concrete storage tanks at Tumbes, a pier with floating p line for loading steamers at Zorritos, and extensive yards, whar and shops at Callao, where the offices are located. The productio crude oil amounts to 11,000 tons annually; some 500,000 gallons kerosene and 100,000 gallons of gasoline were refined at Zorritos year. A recent addition to the plant will increase the productio kerosene by 10,000 gallons a month. A lubricant known as zorri is secured from the residue of the first distillation, and as this is rich character a good business should result from it. Unfortunat he demand at present does not justify a proper plant for its treatnent, so it is mostly consumed as fuel about the property. There as lately been added to the 750 acres of the original property a tract f oil land just north of the Lobitos field, consisting of some 2,700 cres at Cabo Blanco. Steps are being taken to develop this at once.

Lobitos field.—The Lobitos field in the Department of Piura was irst prospected in 1901 by the Peruvian Corporation, but only in 905 was petroleum found in paying quantities. This property now elongs to the Lobitos Oilfields (Ltd.). The company is operating 01 wells, in one group 15 wells from a single engine. The company lso sank some deep wells into a hitherto unexplored sand, which hey believe underlies their whole field. The entire product is at resent marketed in the crude state. These deep wells have proved nly moderately successful, requiring a long time for drilling and eing therefore costly. The cost of the wells 3,000 feet deep averages bout $10 per foot as against $1.50 or $2 a foot for wells under 1,500 eet. One well has been sunk to the depth of 3,435 feet and no oil as yet been obtained; it required 18 months and is the deepest well n the property. Altogether 10 deep wells have been drilled. They re all over 2,000 feet deep. Of these, 6 are producing; 3 proved dry oles; and one is still drilling. The life of these wells is not proved. he following is their record:

No. 100, 2,600 feet, began to produce on March 4, 1910, flowing 300 barrels per day; it was flowing 100 barrels per day on March 31, 1912.

No. 127, 3,046 feet, began to produce on July 5, 1911, flowing 40 barrels per day; it was flowing 36 barrels per day on March 31, 1912.

No. 152, 2,743 feet, began to produce on February 3, 1911, flowing 30 barrels per day; it was flowing 15½ barrels per day on March 31, 1912.

No. 153, 2,580 feet, began to produce on September 27, 1911, flowing 40 barrels per day; it was flowing 25 barrels per day on March 31, 1912.

No. 169, 2,070 feet, began to produce on January 31, 1912, flowing 500 barrels per day; it was flowing 400 barrels per day on March 31, 1912.

Well No. 100 has been by far the largest producer on the property, aving yielded 15,000 tons of oil in two years and one month.

The production of these five wells was at the rate of 2,300 tons per onth, about one-third of the total production. The shallower wells this oil field have proved short lived, but the thickness of the sand the deeper wells favors the expectation that the wells will prove f much longer life. The total production of the field had diminished riously by August, 1911, to 3,738 tons per month, but the new wells rought in after that date caused an average production for the last ur months of 1911 of 5,137 tons. A second tank steamer was built r carrying this oil to the United States and returning with fuel oil.

Puno.—Mention should be made of the work of an American mpany at Puno, near Huancane, on the shore of Lake Titicaca, a rge body of water lying 12,500 feet above the sea on the eastern side f the Andes Range, and forming part of the Bolivian boundary in the uthern part of Peru. Unlike the product of the northern districts, e petroleum of Puno has a paraffin base. A considerable sum has een expended in sinking wells, but the industry has not yet been tablished commercially.

Other districts.—The Lagunitas (British) oil company operates in rthern Peru, shipping through the port of Talara. It has about 5 wells, producing in all about 4,000 barrels a month. Petroleum is so found in the districts of Pirin, Chimbote, Jauja, Huancavelica, and Ica. In fact, it seems to extend at intervals pretty much through the entire mineral belt of Peru, from Tumbes in the north to Lake Titicaca, on the Bolivian frontier, in the south. Outside of the local market, which is constantly growing, oil is sent to Chile, the United States, and even Japan.

Geology.—In regard to the geology of the region, the article states that the stratification inclines downward from the sea and generally to the east. Wells of a depth of only 260 feet have been successfu on the beach and in ravines close by, whereas those of 800, 1,500, an 1,900 feet are usually somewhat farther back. The wells in th second oil sands have reached depths of 2,400 and 2,600 feet, and ye flow.

Local laws.—The laws promulgated by the Peruvian Governmen for the location of oil claims or "denouncements" are liberal, and th rights of the holder are clearly defined and fully protected. Afte the preliminary cost of survey and location the annual tax is £ (about $14.60) per "pertenencia," the unit of claim (approximatel 10 acres), payable semiannually. A bill is before the Peruvia Congress providing for the decrease of this tax by half. The hold of oil or other mining rights may purchase by arrangement, or, i case of disagreement, may expropriate such surface land as he ma legitimately require for exploitation. The oil districts here describe lie mainly in barren and unoccupied land, having little or no surfa value.

PRODUCTION.

The production of petroleum in Peru in recent years is shown in t following tables:

Production of petroleum in Peru, 1902–1911, in tons and barrels.

Year.	Production.	
	Metric tons.	Barrel
1902	[a] 38,230	286
1903	37,079	278
1904	38,683	290
1905	59,720	447
1906	71,506	536
1907	100,830	756
1908	134,824	1,01
1909	175,482	1,31
1910	177,347	1,33
1911	186,405	1,39

[a] Estimated.

One metric ton=7.5 barrels.

Production of petroleum in Peru, 1905–1911, by districts, in barrels.

Year.	Lobitos.	Negritos.	Zorritos.	Lake Titicaca (Huancane).	Total.
1905	[a] 75,000	335,160	37,720		447,880
1906	162,000	330,510	42,419	1,365	536,294
1907	279,000	396,750	65,476	15,000	756,226
1908	319,898	543,750	71,429	[a] 76,103	1,011,180
1909	429,195	740,070	70,750	[a] 76,103	1,316,118
1910	400,080	773,025	107,000	[a] 50,000	1,330,105
1911	391,290	882,698	94,048	[a] 30,000	1,398,036

[a] Estimated.

In the following table are given, so far as can now be ascertained, the production, shipments, and stocks of petroleum and the number of producing wells in the Lobitos oil field of Peru in the years 1905 to 1911, inclusive:

Production, shipments, and stocks of petroleum, and number of producing wells in Lobitos oil field, 1905–1911.

Year.	Production.		Shipments.	Stocks, Dec. 31.	Producing wells Jan. 1.
	Metric tons.	*Barrels.*	*Metric tons.*	*Metric tons.*	
1905	[a] 10,000	75,000			
1906	[a] 21,600	162,000	17,576		
1907	[a] 37,200	279,000	25,821	4,816	
1908	42,653	319,898	36,131	8,860	26
1909	57,226	429,195	54,289	11,797	62
1910	53,344	400,080			
1911	52,172	391,290			

[a] Estimated.

The following table gives the production of petroleum in the Negritos oil field of Peru from 1904 to 1911, in tons and barrels:

Production of petroleum in Negritos oil field, Peru, 1904–1911.

Year.	Production.	
	Metric tons.	Barrels.
1904	39,508	296,310
1905	44,688	335,160
1906	44,068	330,510
1907	52,900	396,750
1908	72,500	543,750
1909	98,676	740,070
1910	103,070	773,025
1911	117,693	882,698

Production of petroleum in Zorritos oil field of Peru, 1902–1911, in gallons.

Year.	Crude petroleum.	Refined.[a]	Gasoline.	Benzine.
1902	2,489,500	373,250	25,920	
1903	2,060,000	276,100	61,745	
1904	2,080,000	365,000	46,200	
1905	1,584,242	300,000	29,570	
1906	1,781,600	350,000	54,000	10,000
1907	2,750,000	420,000	101,000	20,000
1908	3,000,000	500,000	150,000	30,000
1909	2,971,510	469,610	96,520	....
1910	4,494,000	....	....	....
1911	[b] 3,950,000	650,000	....	200,000

[a] Kerosene.

[b] 94,048 barrels.

ARGENTINA.

The Department of State is informed by the American minister a Buenos Aires that on January 21, 1911, a commission of civil engineer appointed by the Argentine ministry of agriculture left that city t investigate the extent of certain oil deposits known to exist in th southeastern part of Argentina, particularly in the district of Comodor Rivadavia, Territory of Chubut.

This investigation is believed to be the outgrowth of a survey this field made a year ago by an American promoter and capitalis Having gone thoroughly over the property in question, this gentlema is said to have offered to undertake its development by the expend ture of $50 000 as an initial outlay. If at the end of the year it wa found that conditions warranted it, the organization of a compan capitalized at $10 000,000 was guaranteed for the further develo ment of the property. The Argentine Government refused this off and is now investigating the field directly.

This deposit is a very viscous, asphaltic material contained in th continental Red Beds, which rest on granite schists, entirely barre of organic material.

It is claimed that the field was actually producing at the end 1911 at the rate of about 1,000 barrels a day. The oil is valued $1.50 a barrel as railroad fuel—about one-eighth of the value of t coal previously used. The field is attracting much attention fro foreign oil producers, and development depends somewhat on t development of proper pipe-line service.

CHILE.

Renewed interest has been manifested in the seepages of oil a especially of natural gas which have been noted by many compete explorers at many points in Chile, but especially in the region Tierra del Fuego. Lately a report by Consul John E. Rowen announ oil in the region of Agua Fresca, within a few hours journey of Pu Arenas.

Among the discoveries were those of the Chilean engineer, Mig Machado, and reports now confirm his investigations. Two Du engineers in the interests of a company in Holland explored natural resources of this territory. Those engineers have just retur from the field of Mr. Machado's prospecting and confirm all his sta ments. They say that all indications show the existence of beds petroleum in the region of Agua Fresca.

COLOMBIA.

Oil seepages are known in many parts of Colombia, especially near Magdalena River about 250 miles from its mouth, and also close to the shore near the Gulf of Darien. A well was in process of drilling by a Canadian company near Cartagena in 1911, and after passing through several somewhat petroliferous zones was continuing to greater depth.

Samples from the oil seepages in this region show the usual black asphaltic oil, but they contain only a small amount of sulphur. The oil has a specific gravity of 0.9296 and gives 1 per cent of gasoline and 26 per cent of kerosene. With the present rapid increase in transportation facilities the development of these oil fields becomes more probable.

BOLIVIA.

Seepages of petroleum have long been known in Bolivia in a belt of country traversing diagonally the eastern Provinces of Santa Cruz, Sucre, and Tarija and extending to the Argentine boundary at Yacuiva. E. F. Moore, British vice consul at Sucre, has recently published a report on the trade of the region in which he states that 160,000 acres have been taken up for petroleum prospecting chiefly by two companies. A law was passed at the end of 1911 exempting fuel and sulphur producers from the annual fiscal tax of about 20 cents an acre. Transportation facilities promise early improvement, and the proper exploration of this country is probable in the near future.

RUSSIA.

GENERAL CONDITIONS.

The total production of petroleum in Russia showed a decline in 1911. Such a decline has been the normal prediction every year since the great decline of 1905, but in spite of it each year since that time has on the contrary shown more or less of an increase until 1911. Even the producers in the old Baku field have by extraordinary efforts achieved an increase until this year. In order to keep up the production the Baku producers have, in addition to drilling new wells and cleaning out old ones, deepened many wells without any especial benefit, and they have gone to the last resort of reopening wells abandoned in the days of abundant production as too poor for profit.

All these expedients combined left Baku with a production in 1911 of 52,138,095 barrels, a decline from 59,764,971 barrels in 1910. This decline was too great for the slowly increasing fields of Grosny and Maikop to compensate so that the total production of Russia amounted to only 66,183,691 barrels in 1911, compared with 70,336,574 barrels in 1910.

This decline in production came at a time when the internal demand was increasing, and an increase in prices became inevitable. As a matter of fact, the price of crude was doubled by the end of the year.

Not only was private enterprise stimulated to increase production, but even the Government was keenly aroused to the necessity of opening new fields for the relief of the trade.

It should be borne in mind in considering the prospects of Russia's future oil trade that very many promising oil prospects are known which would be quickly developed if the favorable conditions of the United States existed in Russia. That they have not been developed thus far has been due to one of two conditions, either the localities lack accessibility or they are on Government land and the Government has not opened them to private exploitation. This latter condition has its analogue in the United States in the public oil lands withdrawn from entry.

An example of this condition in Russia exists in the Grosny district, 8 miles south of Wosdvijenski. This locality is well known for its oil seepages, but it is Government property of the class not open for private enterprise, though the authorities are now considering throwing it open.

It is evidently possible for the Government to afford some relief even in the Baku field itself, where, according to the excellent review of the Moniteur de Pétrole Roumain, the attention of everyone is centered on a tract of about a square mile of probably very rich proved territory belonging to the Government which might be opened, but for which legislation is still required.

On the other hand, the Government aided the search for and opening of new fields. Particularly the Kirghese Steppes, Shemaha, Maikop, and Tcheleken are being explored, as well as many other localities where oil indications are known—such as Djenga. It is also possible that Ferghana may increase, as certain wells which have been drilled are promising and oil has actually been struck in them in satisfactory quantities. In the Kirghese Steppes several wells have been drilled and oil found by an English society with a capital of about $2,000,000. This region is interesting because oil, as at Maikop, is found at relatively slight depths—that is, from 400 to 600 feet—while at Baku it is found below 3,500 feet, and at still greater depths at Grosny. The first oil was struck on the Kirghese Steppes on April 29, 1911. The number of wells in the Maikop region increased markedly during the year, not only near the village of Hadijinskai-Shervanski, but also generally over the supposed petroliferous zone, which extends from that village to the Taman Peninsula, a distance of 150 miles or more. Near the Taman Peninsula at Sirvorco-Cerkiscoe on the shores of the Black Sea Mr. Anton Raki has drilled some wells with a small yield. At the end of 1911 some 60 enterprises were under way in the Maikop region, aided by a pipe line of about 150 miles and tankage to the extent of 20,000 barrels or more. At the end of the year there were about 150 wells in the region, but the exploitation is hindered by Government formalities

There was considerable and increased activity on the island o Tcheleken, with the probability of further energetic exploitation in 1912. The same is true on a smaller scale on the island of Sviatoi which belongs to the Nobel Co. This island is near Baku and represents the prolongation of the Apsheron Peninsula, from which it i separated by only a few hundred yards.

Much hope is centered in the regions of Surakhany and Grosny The former seems to be a prolongation of the petroliferous zone o Balachalai in the Baku region. At first only light oil was obtaine from this region, but for the last two years the usual black oil has als been obtained.

Grosny had a slight increase over the output of 1910, but enoug to show that continued energetic exploitation is probable.

PRODUCTION.

The usual tables of production, refining, and shipment follow:

Production of petroleum in Russia, 1902–1911, by fields.

Year.	Baku.		Grosny.		Maikop.	
	Poods.[a]	Barrels of 42 gallons.	Poods.	Barrels of 42 gallons.	Poods.	Barrels of 42 gallons.
1902	636,529,000	76,414,045	34,369,572	4,125,999		
1903	596,581,155	71,618,386	33,094,000	3,972,870		
1904	614,115,445	73,723,290	40,095,331	4,813,365		
1905	414,762,000	49,791,356	43,057,052	5,168,914		
1906	447,520,000	53,723,889	38,373,603	4,606,675		
1907	476,002,000	57,143,097	39,214,612	4,707,637		
1908	465,343,000	55,863,504	52,058,895	6,249,567		
1909	492,500,000	59,123,650	57,033,015	6,846,700		
1910	497,842,212	59,764,971	74,048,358	8,889,359	1,304,800	156,640
1911	434,310,329	52,138,095	75,189,591	9,026,361	7,933,936	952,453

Year.	Other.		Total.	
	Poods.	Barrels of 42 gallons.	Poods.	Barrels of 42 gallons.
1902			670,898,572	80,540,044
1903			629,675,155	75,591,256
1904			654,210,776	78,536,655
1905			457,819,052	54,960,270
1906	[b] 4,721,000	566,747	490,614,603	58,897,311
1907			515,216,612	61,850,734
1908	[c] 611,221	73,376	518,013,116	62,186,447
1909			549,533,015	65,970,350
1910	[d] 12,708,290	1,525,604	585,903,660	70,336,574
1911	[e] 33,876,295	4,066,782	551,310,151	66,183,691

61.05 poods = 1 metric ton crude.

[a] 8.33 poods crude = 1 United States barrel of 42 gallons.
8 poods illuminating oil = 1 United States barrel of 42 gallons.
8.18 poods lubricating oil = 1 United States barrel of 42 gallons.
9 poods residuum = 1 United States barrel of 42 gallons.
7.50 poods naphtha = 1 United States barrel of 42 gallons.
8.3775 poods other products = 1 United States barrel of 42 gallons, estimated.
1 pood = 36.112 pounds.
1 kopeck = 0.515 cent.

[b] Produced in Bereki and Tchimion oil fields.

[c] Produced in Surakhany.

[d] Includes 10,613,909 poods produced in Surakhany, 1,392,306 poods produced in Sviatoi, 610,500 poods produced in Ferghana, and 91,575 poods produced in Taman.

[e] Includes 19,896,524 poods produced in Surakhany, 2,515,363 poods produced in Sviatoi, 10,205,740 poods produced in Tcheleken, and 610,500 poods produced in Ferghana.

Baku field.—The total production of crude petroleum on the Apsheron Peninsula or Baku field and the shipments of the chief petroleum products from Baku to all points from 1901 to 1911 have been as follows:

Total production of crude petroleum on the Apsheron Peninsula and shipments of petroleum products from Baku, 1902–1911, in barrels.

Year.	Production.	Shipments from Baku.					
		Illuminating.	Lubricating.	Other products.	Residuum.	Crude oil.	Total.
1902	76,414,045	15,026,000	1,750,367	298,657	38,049,555	4,090,036	59,214,615
1903	71,618,386	18,313,125	2,032,347	117,815	33,763,778	3,172,509	57,399,574
1904	73,723,290	19,205,250	1,896,455	159,355	33,622,111	2,249,340	57,132,511
1905	49,791,356	9,209,125	1,303,912	150,045	29,555,777	2,897,359	43,116,218
1906	53,723,889	8,941,125	1,847,799	179,289	22,697,667	4,001,441	37,667,321
1907	57,143,097	11,450,019	1,724,664	565,689	27,833,892	4,290,500	45,864,764
1908	55,863,504	10,682,750	1,754,034	105,163	23,989,778	5,398,200	41,929,925
1909	59,123,650	8,261,368	1,728,833	1,087,115	23,404,954	6,182,973	40,665,243
1910	59,764,971	9,978,406	1,892,046	1,381,921	24,414,210	6,207,278	43,873,861
1911	52,138,095	10,406,454	1,999,503	1,388,776	26,091,096	5,713,538	45,599,367

The division of the production among the districts of the Apsheron Peninsula or Baku field is as follows:

Production of the several districts of the Apsheron Peninsula, 1902–1911, in barrels.

Year.	Balakhani.	Sabunchi.	Romani.	Bibi-Eibat.	Binagadi.	Total.
1902	12,185,354	32,071,908	16,800,000	15,298,200	58,583	76,414,045
1903	10,642,274	27,663,859	14,398,951	18,882,294	31,008	71,618,386
1904	9,848,380	26,029,292	16,063,505	21,745,618	36,495	73,723,290
1905	6,866,747	16,494,310	11,230,732	15,175,558	24,009	49,791,356
1906	8,142,017	18,739,015	11,489,796	15,317,647	35,414	53,723,889
1907	8,594,118	22,036,734	10,750,901	15,761,344	....	57,143,097
1908	8,363,860	23,727,367	9,392,557	14,379,720	....	55,863,504
1909	8,763,505	24,873,950	10,492,198	14,753,901	[a] 240,096	59,123,650
1910	8,228,392	23,379,366	11,532,820	14,265,551	[b] 2,358,842	59,764,971
1911	7,661,934	21,121,650	9,977,837	12,304,431	[c] 1,072,243	52,138,095

[a] Other.
[b] Includes 1,286,599 barrels in other districts.
[c] 1910.

Production of petroleum from pumping and flowing wells in the Baku field, 1902–1911, by districts, in barrels.

Year.	Balakhani.	Sabunchi.	Romani.	Bibi-Eibat.	Binagadi.	Total.
PUMPING.						
1902	12,185,354	30,853,901	12,172,389	9,765,667	58,583	65,035,894
1903	10,642,274	27,302,022	12,822,336	14,396,376	31,008	65,194,016
1904	9,848,380	25,384,514	15,043,217	19,061,944	36,495	69,374,550
1905	6,866,747	16,265,306	9,927,971	14,861,945	24,009	47,945,978
1906	8,142,017	18,513,445	10,436,615	15,282,113	35,414	52,409,604
1907	8,594,118	21,676,950	10,353,782	15,137,215	....	55,762,065
1908	8,363,860	23,585,230	9,250,060	13,529,900	....	54,729,050
1909	8,763,505	24,849,940	9,843,938	12,953,181	[a] 192,077	56,602,641
1910	8,228,392	23,267,266	10,456,391	13,612,313	[b] 1,323,713	56,888,075
1911	7,661,934	21,086,257	9,774,918	11,306,740	[c] 1,072,243	50,902,092

[a] Other.
[b] Includes 251,470 barrels in other districts.
[c] 1910.

Production of petroleum from pumping and flowing wells in the Baku field, 1902–1911, by districts, in barrels—Continued.

Year.	Balakhani.	Sabunchi.	Romani.	Bibi-Eibat.	Binagadi.	Total.
FLOWING.						
1902		1,218,007	4,627,611	5,532,533		11,378,151
1903		361,837	1,576,615	4,485,918		6,424,370
1904		644,778	1,020,288	2,683,674		4,348,740
1905		229,004	1,302,761	313,613		1,845,378
1906		225,570	1,053,181	35,534		1,314,285
1907		359,784	397,119	624,129		1,381,032
1908		142,137	142,497	849,820		1,134,454
1909		24,010	648,260	1,800,720	[a] 48,019	2,521,009
1910		112,100	1,076,429	653,238	[a] 1,035,129	2,876,896
1911		35,393	202,919	997,691		1,236,003

[a] Other.

Number and condition of wells in the Baku fields in years ending Dec. 31, 1910 and 1911.

Condition of wells.	Balakhani.		Sabunchi.		Romani.		Bibi-Eibat.		Total.	
	1910	1911	1910	1911	1910	1911	1910	1911	1910	1911
Completed	40	27	98	62	43	27	28	19	209	135
Producing, Dec. 31	762	778	915	966	223	254	266	282	2,166	2,280
Trial pumping, Dec. 31	6	19	24	34	5	5	9	8	44	66
Drilling, Dec. 31	22	24	56	68	27	31	40	34	145	157
Drilling deeper, Dec. 31	33		95		53		55		236	
Cleaning out and repairing	4	10	16	24	14	9	5	9	39	52
Standing idle	393	365	629	666	228	228	163	162	1,413	1,421
Rigs up, ready for drilling	16	16	44	47	11	4	13	13	84	80
New wells sunk	40	45	76	91	30	37	23	13	169	186
Length of wells drilled, in feet	62,349	65,751	144,053	132,475	65,590	60,039	65,919	54,019	337,911	312,284

The stocks of petroleum and petroleum products in the Baku field at the close of the year from 1907 to 1911 were as follows:

Stocks of petroleum in Baku, Dec. 31, 1907–1911, in barrels.

	1907	1908	1909	1910	1911
At oil wells: Crude	720,288	1,032,413	1,080,432	938,391	906,625
At refineries:					
Crude	2,028,812	1,239,736	2,495,087	3,073,853	1,887,270
Illuminating	1,225,000	675,375	938,971	947,024	1,028,885
Lubricating	268,949	195,600	247,358	272,017	272,170
Residuals	3,822,222	4,804,333	4,703,372	5,647,526	3,195,771
Other products	179,051	119,370	234,048	224,240	306,825
Total	8,244,322	8,066,827	9,699,268	11,103,051	7,597,546

Grosny field.—The following tables show the production in the Grosny field from 1907 to 1911:

Production of petroleum in the Grosny oil field, 1907–1911, in poods and barrels.

Year.	Pumping.		Flowing.		Total.	
	Poods.	*Barrels.*	*Poods.*	*Barrels.*	*Poods.*	*Barrels.*
1907	33,840,762	4,062,517	5,373,850	645,120	39,214,612	4,707,637
1908	37,741,980	4,530,850	14,316,915	1,718,717	52,058,895	6,249,567
1909	50,997,451	6,122,143	6,035,564	724,557	57,033,015	6,846,700
1910	58,097,733	6,974,518	15,950,625	1,914,841	74,048,358	8,889,359
1911	71,481,505	8,581,213	3,708,086	445,148	75,189,591	9,026,361

Well record in the Grosny field in 1907–1911.

Year.	Number of plats.		Total wells.	Producing, Dec. 31.	Boring and deepening, Dec. 31.	Average depth of wells.	Total sum of depth of producing wells.	Total length of wells drilled in the year.
	Producing.	Being exploited.						
						Feet.	*Feet.*	*Feet.*
1907	....	....	271	205	45	....	185,346	....
1908	....	....	287	172	51	1,348.2	203,574	....
1909	....	....	320	182	58	1,458.1	250,831	82,537
1910	44	71	343	234	67	1,557	....	87,836
1911	80	195	358	195	61	1,670	....	72,933

Crude petroleum on hand in Grosny field Jan. 1, 1910, 285,829 barrels; Dec. 31, 1910, 787,949 barrels; Dec. 31, 1911, 141,649 barrels.

Novorossisk.—The following tables show the shipments of petroleum and its products from Novorossisk from 1906 to 1911, and stocks on December 31, 1911:

Shipments of petroleum from Novorossisk, 1906–1911.

Year.	Crude oil.	Illuminating.[a]	Benzine.	Residuals.	Total.
	Barrels.	*Barrels.*	*Barrels.*	*Barrels.*	*Barrels.*
1906	486	435,670	86,230	347,858	870,244
1907	770	246,246	299,658	209,812	756,486
	Tons.	*Tons.*	*Tons.*	*Tons.*	*Tons.*
1907	....	34,414	31,543	24,922	90,879
1908	....	15,824	38,690	18,112	72,626
1909	....	23,248	54,800	49,920	127,968
1910	6,025	32,187	63,232	67,973	169,417
1911	18,690	62,044	65,520	76,092	222,346

[a] Refined.

Stocks of petroleum at Novorossisk, Dec. 31, 1911.

	Poods.	Barrels.
Crude	179,800	21,58
Illuminating oils	317,600	39,70
Astatki	282,000	31,33
Other products	1,361,000	162,45
Total	2,140,400	255,07

Batum.—The following table shows the shipments of petroleur products from Batum from 1908 to 1911:

Shipments of petroleum from Batum, 1908–1911.

Year.	Refined petroleum.	Lubricating.	Residuals.	Total.
	Tons.	*Tons.*	*Tons.*	*Tons.*
1908	460,580	141,986	70,820	673,3
1909	405,857	164,840	78,839	649,5
1910	423,993	157,608	45,811	627,4
1911	353,518	171,725	57,282	582,5

The following were the stocks of petroleum products held at Batum at the close of the year from 1908 to 1911, in poods and barrels:

Stocks of petroleum at Batum, Dec. 31, 1908–1911.

	1908		1909		1910		1911	
	Poods.	*Barrels.*	*Poods.*	*Barrels.*	*Poods.*	*Barrels.*	*Poods.*	*Barrels.*
Illuminating..	3,484,000	435,500	2,700,000	350,000	2,590,778	323,847	2,216,007	278,251
Lubricating...	1,124,000	137,410	972,000	118,826	1,092,431	133,670	888,605	108,631
Solar oil.......	97,000	11,758	24,000	3,000	522,032	60,000	300,585	35,880
Vaseline......	23,000	2,644	158,000	18,860				
Residuals.....	714,000	79,333	577,000	64,111				
Total...	5,442,000	666,645	4,431,000	554,797	4,205,241	517,517	3,405,197	422,762

Sakhalin.—A report has been made to the Bureau of Manufactures, Department of Commerce and Labor, by Consul Lester Maynard, of Vladivostok, Siberia, regarding the oil fields of Russian Sakhalin Island. This report, it is stated, is made from notes prepared by Mr. A. F. Brown, who personally inspected the oil fields.

The report gives the history of the operations that have been conducted on the island. It is stated that the oil springs and asphalt lakes of Sakhalin recently have attracted much attention in the mining world. There are said to be thirteen of these groups, and in one section alone more than 200 springs, ranging in size from a few drops a minute to a stream the size of a man's finger.

Consul Maynard's report covers the operations of companies in this province of Russia, the character of the paraffin produced, the development work, and a variety of subjects connected with the oil development in these fields, as follows:

The bitumen is found in all stages of density, from the consistency of tar up to a hard smooth-surfaced mass resembling an asphalt floor. The lake near Oha Creek is over 1,000 feet long and 400 feet wide and from 2 to 6 feet deep, containing over 25 000 tons of an asphaltlike substance of such a tough nature that it took two hardy Russian laborers two and one-half days to sink a shallow pit 6 feet deep to the hard clay bottom. The asphalt appeared to be comparatively clean of foreign substances.

Only four concerns of any importance are interested in the Russian Sakhalin oil fields. The most active organization in the field is doubtlessly the China Oil Co., headed by the German engineer Kleye and backed by Tientsin capital, but although about $200 000 have been expended on pipe lines, telephones and houses on the claims along Nutovo and Boatasin creeks only two holes of small diameter have been sunk by hand drills, and the first steam drill was started late in 1909. The results are as yet unknown, although the Vladivostok papers have reported that a flow of oil has been struck.

The St. Petersburg company, of which Prince Radziwill is the head, was organized under English law as the Second Sakhalin Oil Syndicate, and has been diligently engaged in staking claims, of which it now has over 300 scattered over the entire Sakhalin oil territory, and all these claims have been registered with the Sakhalin district engineer, Medviedeff. Active boring operations were not promised until the summer of 1911.

The Vladivostok company, headed by Engineer Artz, from Poland, is composed of about 40 members, consisting of military and civil officials and business men of Vladivostok and the neighboring territory. This company has succeeded in staking claims in nearly all localities where oil springs and paraffin lakes have been found, and has apparently engaged well-informed prospectors. Its claims may be reached from five harbors.

The oldest concern is the Zotoff Co., backed by Shanghai capitalists. The property of this company consists of about 1 800 acres in Oha Creek, and was granted in 1889, and no work of any kind was performed for 21 years, until the fall of 1910. The first hole of the Zotoff claim was started in December, 1910, in about 7 feet of snow, on Oil Creek, in the neighborhood of a number of lively oil springs and within a quarter of a mile of the big paraffin lake.

AUSTRIA-HUNGARY.

GALICIA.

Production.—During 1911 the decline of oil production in Galici continued. In 1910 this decrease amounted to more than 15 per cen from the production of 1909, and in 1911 the proportion was stil greater. This was owing not only to the disturbed conditions consequent to active competition between the United States and othe countries for the control of foreign markets, but was aggravated by th entrance of salt water in alarming quantities into various of th wells at Tustanovitz. The market conditions, however, promise a improvement in 1912, and the commission which has examined th threatening invasion of water does not find the condition as seriou as was supposed.

Production of petroleum in Galicia, 1902–1911.

Year.	Metric. centners.[a]	Barrels of 42 gallons.	Year.	Metric centners.[a]	Barrels 42 gallon
1902	5,760,600	4,142,159	1907	11,759,740	8,455,
1903	7,279,710	5,234,475	1908	17,540,220	12,612,
1904	8,271,167	5,947,383	1909	20,767,400	14,932,
1905	8,017,964	5,765,317	1910	17,625,600	12,673,
1906	7,604,432	5,467,967	1911	14,582,750	10,485,

[a] 1 metric centner or quintal=100 kilograms (220.462 pounds); 1 metric centner or quintal of cru petroleum=0.71905 barrel of 42 gallons.

In the following table is given the production of petroleum in alicia in 1906 to 1911, inclusive, by fields, in tons:

Production of petroleum in Galicia, 1906–1911, by fields, in metric tons.[a]

Field.	1906	1907	1908	1909	1910	1911
ast Galicia:						
Tustanowice	562,198	1,011,590	1,318,710	1,706,435	1,404,320	1,105,325
Boryslaw			266,910	231,195	209,300	197,950
Schodnica	47,151	39,650	36,480	34,860	32,860	155,000
Urycz	17,930	13,510	30,022	28,110	38,170	
Mraznica	....	1,490				
Other fields	13,830	12,230				
est Galicia:						
Potok	16,325	13,850	50,640	11,370	13,010	
Rogi	11,452	9,033		9,540	8,200	
Rowne	1,536	1,981				
Krosno	34,268	29,960		20,690	25,200	
Tarnawa-Wielopole-Zagorz	[b] 24,870	17,390	18,200	6,770	2,700	
Kobylanka, Kryg, Zalawie, Lipinki, Libusza, etc.	30,883	25,290	33,060	27,770	28,800	
Total	760,443	1,175,974	1,754,022	2,076,740	1,762,560	1,458,275

[a] 1 metric ton=7.1905 barrels of crude petroleum of 42 gallons=2,204.62 pounds.

[b] Tarnawa.

Deliveries of Galician petroleum to refineries, 1908–1911, in metric tons.

	1908	1909	1910	1911
elivered to refineries:				
In Galicia and Bucovina	457,020	451,290	362,160	392,020
In the rest of Austria	540,820	672,970	547,950	488,770
In Hungary	338,720	384,090	319,380	347,550
o the State refinery in Drohobycz	....	....	208,760	337,340
Total	1,336,560	1,508,350	1,438,250	1,565,680
xported	....	41,920	3,280	840
sed as fuel	....	120,000	97,430	90,120
tocks in the Government reservoirs	....	406,470	819,700	[a] 871,330
Total	....	2,076,740	2,358,660	2,527,970

[a] Does not include producers' storage, which decreased from 858,490 tons to 605,280 tons.

Imports and exports.—In the following table are given the imports nd exports of petroleum products into and from Austria-Hungary in 909, 1910, and 1911:

mports and exports of petroleum into and from Austria-Hungary in 1909, 1910, and 1911, in metric tons.

Kind.	1909		1910		1911	
	Imports.	Exports.	Imports.	Exports.	Imports.	Exports.
luminating oils	1,761	290,915	1,460	266,739	1,460	220,499
ubricating and other oils	19,614	130,862	15,358	139,071	18,322	135,514
enzine	10	32,528	40	39,320	10	41,904
araffin	507	38,042	455	44,432	632	37,940
ude petroleum	....	51,558	18,967	5,472	19,020	610
Total	21,892	543,905	36,280	495,034	39,394	436,467

HUNGARY.

The Transylvania oil and gas fields are being given careful consideration by the Hungarian Government, though the actual production in 1911 did not enter as a considerable factor in comparison to the decline in Galicia.

ROUMANIA.

Geologic conditions.—Petroleum occurs in Roumania so far up on the southern slope of the Carpathian Range that the region is characterized by narrow, sharp, and eccentric folding, and even in places by much faulting, as at Moreni. This geologic condition invests the Roumanian oil fields with eccentricities almost equal to those in the Gulf region in the United States, although the latter are of entirely different geologic character. As a result of this folding and faulting there has been abundant opportunity for the ingress of the petroleum to the region where it is found, and equal opportunity for accumulation in anticlinal ridges with a cover sufficient to prevent its expulsion by water. As might be expected, the supply of oil is, therefore frequently great in regions with very narrow boundaries. From such conditions the trade may always expect fluctuations in production dependent not only upon the course of trade but upon the accident of discovery and the varying speculative energy which seeks the erratic course of the oil.

Production.—Such a point of view is necessary in explaining the fact that the production of Roumania, which has been increasing satisfactorily for many years, came near being stationary in 1910 and then took an upward turn of 14.2 per cent in 1911, reaching th highest point in petroleum production ever known in Roumania—11,101,878 barrels.

Practically on a sliding scale with the increased production, th quantity of oil treated in the refineries of Roumania increased an also proportionate was the yield of benzine, illuminating oil, an residuals, with a trifling decline in the quantity of lubricating o produced. The lubricating oil consumed, however, increased satisfactorily, as did every other item of domestic consumption.

Exports declined, with the exception of crude oil and the triflin export of paraffin wax, and stocks accumulated, as shown in th following tables.

The Prahova district, which contains the Bustenari field, formerl dominating the Roumanian petroleum production, declined in i percentage of the total from 92.10 to 89.67 per cent, but all the oth districts showed an increase. The decline in Bustenari was so marke that the Prahova field would have shown a much greater decli had it not been for the increase in Moreni, where the monthly pr duction, beginning with 38,222 metric tons in January, increased 71,149 metric tons in October, and settled down to 56,239 tons December.

Among the developments of the year in well drilling the mo significant was the great gusher No. 2, Astra-Roumania. This deve oped the Bana pool of the Moreni field at the beginning of the yea Several other very heavy gushers were encountered and the erupti of oil and gas was so sudden as to cause violent explosions with co

derable loss of life. Astra No. 7, for example, burned for 22 days
ith a great loss of oil and the lives of the civil engineer and several
orkmen. In addition to the activity in developing oil land between
oreni and Tsintea, several companies began active developments
ear Urlatzi-Ceptura.

In addition to about 100 pipe lines now existing in Roumania and
ggregating about 1,000 miles in length, the proposition of construct-
g pipe lines from the producing fields to Constanza was very actively
gitated, there being a great deal of discussion between rival com-
anies as to the advisability of this scheme. Finally a law has been
assed giving 30,000,000 francs and authorizing the construction of
e line.

Roumanian petroleum industry, 1906–1911, in metric tons.

	1906	1907	1908	1909	1910	1911
ude-oil production	887,091	1,129,097	1,147,727	1,297,257	1,352,407	1,544,072
ude oil treated at refineries	748,798	950,614	1,012,616	1,107,825	1,215,299	1,404,403
ıtput of refineries:						
Benzine	114,428	146,263	180,190	201,253	230,703	260,653
Illuminating oil	221,683	261,684	248,274	263,998	272,222	312,711
Lubricating oil	53,588	57,337	89,753	43,446	25,064	24,703
Residuals	333,714	452,685	473,770	576,600	667,260	783,136
ome consumption:						
Benzine	4,059	5,689	9,055	14,041	20,314	24,450
Illuminating oil	35,243	38,467	38,422	39,451	41,849	43,941
Lubricating oil	9,848	9,047	11,955	15,698	17,544	22,401
Residuals	237,477	332,999	347,323	366,703	360,551	434,094
Fuel at the refineries	....	....	113,753	109,077	108,314	123,029
xports:						
Benzine	71,114	89,522	122,860	108,218	125,751	125,060
Illuminating oil and distillate	196,631	262,489	263,633	261,637	339,282	323,012
Crude, residuals, etc	53,374	78,423	78,765	49,715	116,223	231,327
Paraffin	....	151	187	545	285	488
ocks on Dec. 31:						
Benzine	18,275	47,506	44,783	40,071	29,006	51,862
Illuminating oil	48,967	36,128	41,541	79,613	56,557	73,908
Lubricating oil and residuals	67,334	67,816	73,761	157,204	270,493	248,375

roduction of petroleum in Roumania in 1911, by districts and months, in metric tons.[a]

Month.	District Prahova.					Dambovitza.	Buzeu.	Bacau.	Total.
	Bustenari-Calinet-Bordeni.	Campina Poiana.	Moreni.	Other.	Total.				
ınuary	25,121	29,127	38,222	9,971	102,441	4,610	3,515	1,947	112,513
ebruary	25,988	24,461	25,260	10,208	85,917	3,609	2,974	2,055	94,555
arch	30,486	28,218	32,683	12,163	103,550	4,480	3,535	2,036	113,601
pril	30,142	23,267	35,907	10,736	100,052	5,075	5,100	2,085	112,312
ay	29,579	24,210	39,828	14,549	108,166	7,394	5,691	2,333	123,584
ıne	26,293	23,746	48,328	22,018	120,385	8,600	5,552	2,248	136,785
ıly	28,274	30,926	57,616	13,123	129,939	7,255	6,166	2,425	145,785
ugust	23,939	26,442	58,530	16,071	124,982	5,882	7,002	2,841	140,707
ptember	24,637	25,777	64,065	18,459	132,938	5,334	7,769	2,419	148,460
ctober	22,670	28,423	71,149	16,288	138,530	6,426	6,614	2,242	153,812
ovember	22,970	24,588	57,427	16,631	121,616	5,294	5,065	2,640	134,615
ecember	21,860	23,849	56,239	14,098	116,046	5,118	3,997	2,182	127,343
Total	311,959	313,034	585,254	174,315	1,384,562	69,077	62,980	27,453	1,544,072

[a] 1 metric ton=7.19 barrels of 42 gallons.

The percentages of the total production furnished by each of the Departments of Roumania is given in the following table:

Percentage of production of petroleum in Roumania, 1907–1911, by Departments.

Department.	1907	1908	1909	1910	1911
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Prahova	95.45	95.49	94.23	92.10	89.67
Dambovitza	2.86	2.29	2.33	3.20	4.47
Buzeu	.88	.93	1.96	2.94	4.08
Bacau	.81	1.29	1.48	1.76	1.78
Total	100.00	100.00	100.00	100.00	100.00

Percentage of refined products from Roumanian crude petroleum, 1907–1911.

Product.	1907	1908	1909	1910	1911
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Crude benzine	15.4	17.8	18.1	19.0	18.
Illuminating oil	27.5	24.7	23.8	22.4	22.
Lubricating oil	4.4	8.8	3.9	2.0	1.
Residue	47.3	46.7	52.0	54.9	55.
Loss	3.4	2.0	2.2	1.7	1.

The production of petroleum in Roumania in the last 10 years has been as follows:

Production of petroleum in Roumania, 1902–1911, in barrels.

Year.	Quantity.	Year.	Quantity.
1902	2,059,935	1907	8,118,2
1903	2,763,117	1908	8,252,1
1904	3,599,026	1909	9,327,2
1905	4,420,987	1910	9,723,8
1906	6,378,184	1911	11,101,8

Well record.—The well record in Roumania in 1911 is shown i the following table:

Well record in Roumania in 1911, by districts.

District.	Jan. 1, 1911.						Dec. 31, 1911.					
	Bore holes.			Hand wells.			Bore holes.			Hand wells.		
	Producing.	Drilling.	Abandoned.	Producing.	Drilling.	Abandoned.	Producing.	Drilling.	Abandoned.	Producing.	Drilling.	Aba done
Prahova	700	203	274	132	67	433	709	220	441	125	104	
Dambovitza	15	17	22	68	9	118	17	14	30	71	12	
Buzeu	26	16	10	44	4	63	39	21	16	44	2	
Bacau	78	8	13	303	25	472	75	5	27	304	31	
Total	819	244	319	547	105	1,086	840	260	514	544	149	1,

Exports.—In the following table are given the exports of petroleum products from Roumania in the years 1908, 1909, 1910, and 1911, in tons:

Exports of petroleum products from Roumania in 1908, 1909, 1910, and 1911, in metric tons.

Kind.	1908	1909	1910	1911
Crude oil, gas oil, lubricating oil, and residuals	76,196	49,715	116,223	231,327
Illuminating oil	262,176	261,637	339,282	323,012
Benzine	122,332	108,218	125,751	231,327
Paraffin scale	....	545	285	488
Total	460,704	420,115	581,541	786,154

GERMANY.

In the following table are shown the quantity and value of petroleum produced in the German Empire, by States, from 1902 to 1911, inclusive:

Production and value of petroleum in the German Empire, 1902–1911, by States.

Year.	Alsace-Lorraine.	Prussia and Bavaria.	Total.		Total value.	
	Quantity.	Quantity.	Quantity.			
	Metric tons.	*Metric tons.*	*Metric tons.*	*Barrels (42 gallons).*	*Marks.*	*Dollars.*
1902	20,205	29,520	49,725	353,674	3,351,000	797,538
1903	20,947	41,733	62,680	445,818	4,334,000	1,031,492
1904	22,016	67,604	89,620	637,431	5,805,000	1,381,590
1905	21,128	57,741	78,869	560,963	5,207,000	1,239,266
1906	[a] 22,154	59,196	81,350	578,610	5,036,000	1,198,568
1907	[a] 26,124	80,255	106,379	756,631	7,056,000	1,679,328
1908	[a] 28,898	113,002	141,900	1,009,278	9,942,000	2,366,196
1909	[a] 29,726	113,518	143,244	1,018,837	10,118,000	2,408,084
1910	....	....	145,168	1,032,522	10,146,000	2,414,748
1911	....	....	[b] 140,000	995,764	9,790,285	2,330,088

[a] Includes Bavaria.

[b] Estimated.

1 metric ton, crude=7.1126 barrels.

GREAT BRITAIN.

Oil shale.—In the following table is shown the production of oil shale in Great Britain in 1902 to 1910, taken from the Mineral Statistics of the United Kingdom:

Quantity and value of oil shale produced in Great Britain, 1902–1910, in long tons.

Year.	England.		Scotland.		Wales.		Total.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
1902	....	....	2,105,953	$2,434,277	1,581	$2,886	2,107,534	$2,437,163
1903	193	$282	2,009,265	2,222,294	144	263	2,009,602	2,322,839
1904	....	....	2,331,885	2,695,578	1,177	2,146	2,333,062	2,697,725
1905	2,000	2,920	2,493,081	2,881,343	1,704	2,890	2,496,785	2,887,153
1906	....	....	2,545,724	3,200,449	798	1,358	2,546,522	3,201,807
1907	....	....	2,690,028	3,923,971	....	....	2,690,028	3,923,971
1908	....	....	2,892,039	3,870,118	....	....	2,892,039	3,870,118
1909	40	34	2,967,017	3,970,723	....	....	2,967,057	3,970,757
1910	....	....	3,130,280	4,189,114	....	....	3,130,280	4,189,114

NEW SOUTH WALES.

Quantity and value of oil shale produced in New South Wales, 1902–1911, in long tons.

Year.	Quantity.	Value.
1902	62,880	$290,613
1903	34,776	139,265
1904	37,871	130,276
1905	38,226	103,399
1906	32,446	138,549
1907	47,331	154,996
1908	46,303	126,855
1909	48,718	114,93
1910	[a] 50,000	115,00
1911	[a] 60,000	138,00

[a] Estimated.

ITALY.

Production was limited to the few small wells described in previou reports. But during 1911 a governmental commission of the minin department of Bologna made an exhaustive investigation and repor on the petroliferous areas in Emilie. They conclude that chances ar good for a considerable oil supply from the mountainous portions o the district.

Production.—In the following table will be found the productio and value of petroleum in Italy from 1902 to 1911. This table i taken from the volumes of the Rivista del Servizio Minerario:

Production of petroleum in Italy, 1902–1911.

Year.	Number of wells in operation.	Quantity.		Value.	
		Metric tons.	United States barrels.	Lire.[a]	Dollar
1902	9	2,633	18,933	778,163	150,
1903	10	2,486	17,876	737,293	142,
1904	10	3,543	25,476	1,053,294	203,
1905	9	6,123	44,027	1,826,802	352,
1906	12	7,451	53,577	2,226,559	429,
1907	13	8,327	59,875	1,663,300	321,
1908	14	7,088	50,966	1,415,640	273,
1909	12	5,895	42,388	1,178,660	227,
1910	9	7,069	50,830	1,413,800	272,
1911 [b]	9	10,000	71,905	2,000,000	386,

[a] Lira=$0.193. 1 metric ton, crude=7.1905 barrels.

[b] Estimated.

BRITISH INDIA.

Production.—The following table gives the production of petroleum in India from 1902 to 1911 in imperial gallons reduced to barrels of 42 gallons and in rupees reduced to dollars:

Production and value of petroleum in India, 1902–1911.

Year.	Quantity.		Value.	
	Imperial gallons.	Barrels (42 United States gallons).	Rupees.[a]	Dollars.
1902	56,607,688	1,617,363	3,267,245	1,058,587
1903	87,859,069	2,510,259	5,315,470	1,722,212
1904	118,491,382	3,385,468	7,109,566	2,303,499
1905	144,798,444	4,137,098	9,063,051	2,936,429
1906	140,553,122	4,015,803	8,613,576	2,790,799
1907	152,045,677	4,344,162	9,150,225	2,968,637
1908	176,646,320	5,047,038	10,530,135	3,416,327
1909	233,678,087	6,676,517	13,652,580	4.429,352
1910	214,829,647	6,137,990	12,538,905	4,068,039
1911	225,792,094	6,451,203	13,265,970	4,303,923

[a] The value of the rupee is taken as 32.44⅓ cents; 15 rupees=£1.

Production of petroleum in India, 1906–1911, by provinces, in imperial gallons.

Province.	1906	1907	1908	1909	1910	1911
Burma	137,654,261	148,888,002	173,402,790	230,396,617	211,507,903	222,225,531
Eastern Bengal and Assam	2,897,990	3,156,665	3,243,110	3,280,750	3,320,680	3,565,163
Punjab	871	1,010	420	720	1,064	1,400
Total	140,553,122	152,045,677	176,646,320	233,678,087	214,829,647	225,792,094

Imports.—The statistics of petroleum imports into India during 1910, as compared with the figures for 1908 and 1909, are as follows:

Imports of petroleum into India in 1908, 1909, and 1910, by countries, in imperial gallons.

Country.	1908	1909	1910
Russia	4,156,690	7,207,322	5,842,000
Roumania	20,907,685	3,919,632	....
Lund Archipelago	24,250,488	19,839,905	15,893,000
United States	31,431,505	39,547,142	34,839,000
Other countries	464	378	24,000
Total imports	80,747,014	70,514,379	56,598,000
From Burma	76,767,293	71,698,635	92,076,000
Grand total	157,514,307	142,213,014	648,674,000
Other products	12,990,989	14,187,532	....

Oil-well drilling in Burma.—A. M. Finlayson in the Mining Magazine for February, 1912, describes the labor conditions in Burma. Rig builders and rough carpenters are Burmans, as are the coolies employed around the well—six or seven to a well. These men have spent a large part of their lives at such work and are used to handling the tools and cables. A new driller with no knowledge of the language has little trouble in working with these coolies. They become good tool dressers. The Burmans do all the bullock-cart transportation.

Work which requires much patience and ingenuity is usually given to the "natives" of India, chiefly coolies and small merchants. The care-free Burman has no liking for details. The usual coolie wage is 8 annas a day or 15 rupees a month.

The drillers (chiefly from Pennsylvania and Ohio) receive 600 rupees ($200) a month on three-year contracts, which are frequently renewed. There are about 150 such drillers. Most of the work is done by standard rigs which have supplemented the Canadian system.

DUTCH EAST INDIES.

In the following table is given the production of petroleum in the Dutch East Indies during the years 1902 to 1911, inclusive:

Production of petroleum in Dutch East Indies, 1902–1911.

Year.	Borneo.		Java.		Sumatra.		Total.		
	Metric tons.	Liters.	Metric tons.	Liters.	Metric tons.	Liters.	Metric tons.	Liters.	Barrels.
1902...	84,232	93,323,718	54,455	63,182,955	186,655	229,900,893	325,342	386,407,566	2,430,4
1903...	105,102	116,446,337	91,568	106,244,811	563,988	694,661,269	760,658	917,352,417	5,770,0
1904...	215,109	238,327,180	110,053	127,692,388	542,936	668,731,900	868,098	1,034,751,468	6,508,4
1905...	439,487	486,924,000	110,711	128,456,000	513,630	632,635,700	1,063,828	1,248,015,700	7,849,8
1906...	387,455	429,275,398	111,378	129,229,083	602,501	742,097,300	1,101,334	1,300,601,781	8,180,6
1907...	489,151	541,948,068	142,983	165,900,000	713,841	879,235,063	1,345,975	1,587,083,131	9,982,5
1908...	511,049	566,209,890	137,013	158,974,000	738,588	909,715,827	1,386,650	1,634,899,717	10,283,3
1909...	411,506	455,922,397	140,351	162,846,428	922,894	1,136,720,015	1,474,751	1,755,488,840	11,041,8
1910...	633,472	701,853,114	142,503	165,344,877	719,740	886,505,130	1,495,715	1,753,703,121	11,030,6
1911...	814,707	902,654,621	172,438	190,766,435	683,523	841,895,279	1,670,668	1,935,316,335	12,172,9

1 gallon Borneo crude=7.5322 pounds.
1 gallon Java crude=7.1924 pounds.
1 gallon Sumatra crude=6.7754 pounds.
1 United States barrel=158.985 liters; 1 liter=1.0567 quarts.

BRITISH NORTH BORNEO.

Prospects.—According to Vice Consul John N. Wardrop, of Sand
kan, a small syndicate had geologists and surveyors in North Born
during 1908 and 1909, the result of their investigations being t
formation of the present British-Borneo & Burma Petroleum Sync
cate (Ltd.), which is said to have secured oil rights over a fair
large tract of land from the British North Borneo Governme
No oil derrick or rig has yet been erected, though the syndica
is now taking some initial steps toward development in the neighb
hood of Mansut, Brunei Bay, near Labuan. Sydney H. North, in
article in the Financial News, in 1911, writes:

> Petroleum in Borneo is contained in regular occurrences of oil belts of narrow wid
> but of great length, and the oil indications in British North Borneo coincide w
> remarkable similarity with those existing on the east coast oil fields, which indu
> the successful Shell Co. to make its first trial borings. In both parts of the isla
> the same geological conditions prevail, the oil being found in the Tertiary format
> of the Miocene period, which contains the rich oil-bearing strata of this country.
> oil here is associated with enormous gas pressure. Most of the wells start as gush
> The oil generally occurs in sandstone. The petroleum-bearing lands of Bri
> North Borneo are those on which the most recent attention has been fixed, and t
> are, from geological and other indications, believed to bear an intimate relations
> with and be closely allied to the deposits of Dutch Borneo.

Wells.—At the annual meeting of the Shell Transport & Trad
Co. at London, in June, 1911, the chairman spoke optimistically

he prospects of oil production in Sarawak, British North Borneo.
'he output has substantially increased. Oil was struck in Sambojia,
he first well, 2,000 feet from the apex of the anticlinal, giving a
upply of 20 tons a day. The immediate construction of a pipe line
apable of carrying 1,200 tons a day to the refineries at Balik Papan
as been recommended. An additional well, sunk 500 feet from the
ıainland, gave 165 tons a day, increasing since to 185 tons. As
ver 4,000,000 tons of oil have already been taken from the Sanga
anga wells, and as the area of Sambojia is even greater, the latter
eld is regarded as valuable. A deep well giving 850 tons a day,
t Sanga Sanga, in an entirely new strata, practically renewed the
fe of that field, to which a new pipe line will be laid. The oil of the
ambojia field is valuable, as it contains 16 per cent paraffin, and the
ax plant is reported as a complete success. This company
nnounced a final dividend for 1910, making 22½ per cent for the
ear.

Early in 1911 Consul O. H. Baker reported that 4 tons of oil a
ay was being produced in Sarawak at Miri, in British North Borneo.

NEW ZEALAND.

A report has been received at the Bureau of Manufactures, Depart-
ıent of Commerce and Labor, from Vice Consul General Henry D.
Baker, who is on special service to New Zealand regarding the mineral-
il and iron fields of that country. The references in this report to
he oil fields and production are contained in the following para-
raphs:

On the western coast of the North Island of New Zealand, in the vicinity of Mount
gmont and close by the sea at New Plymouth, there has been for many years more
less attention paid to promising indications of mineral oil, but until recently
ttempts to bore for the oil have not met with much success, the wells apparently
ot being sunk to a sufficient depth to get the oil. Lately, however, three bores
ınk by one company to a depth of about 2,500 feet have resulted in a fair flow of oil
eing obtained, and also a strong pressure of natural gas has been revealed. From
ıese bores about 20 barrels of oil a day are now being obtained, this oil being shipped
a crude state to Auckland and Wellington, where it is used in the local gas works.
he New Zealand Government some time ago offered a bonus of 6 cents a gallon on
ıe first 500,000 gallons of mineral oil produced in the dominion, and the company
perating at New Plymouth has just claimed and been allowed one-half of this
onus, amounting to $15,000, for the first 250,000 gallons produced. The attention
English capitalists has been drawn to the district, and it is now reported that a
le of the property owned by this company to an English syndicate has been effected
ad that a new company will shortly be formed, improved machinery purchased for
oring operations, and a refinery erected. It is also proposed to utilize the natural
ıs for power purposes. The oil appears to be rich in materials valuable as by-prod-
cts. Refined samples contained about 15 per cent of petroleum spirit below 150°
. (302° F.), 42 per cent of kerosene distilling between 150° and 300° C. (302° and
2° F.), about 20 per cent of lubricating oil, 13 per cent of paraffin, and 5 per cent of
ke.

At Kotuku, in the western part of the South Island, several small gushers of oil
ıve recently been found, from which a mixture of kerosene and salt water has been
ınning, and an up-to-date boring plant for proper testing of this district has been
dered from the United States.

The Government of New Zealand is at present engaged in an extensive survey of
istricts in both North and South Islands, where there is supposed to be mineral oil.
preliminary report covering the petroleum field in the vicinity of New Plymouth
ıs already been issued. This report states that there can be no doubt that there are
omising surface indications within a radius of about 15 miles of New Plymouth, but
ıe boundaries of the petroleum field can be defined exactly only by systematic
illing. Natural gas in this district is also widespread, and where it occurs in quan-
ty there is a strong probability that it has ascended vertically from porous strata
elow, which very likely contain petroleum as well. The greatest attention, the

report suggests, should be given to all geological details before selecting bore-hole sites, as there is danger that the lower part of the petroliferous strata may contain water instead of gas and oil, or may be calcified or silicified instead of being bituminized. In general, it is reported by the director of the geological survey that the chances for oil in this district are as good as in any imperfectly tried field, and it is hoped that after the observations of the survey are complete the industry will be pushed as vigorously as the surface indications seem to warrant.

JAPAN.

In the following table is given the production of petroleum in Japan from 1902 to 1911, inclusive:

Production of petroleum in Japan, 1902–1911.[a]

[Barrels of 42 gallons.]

Year.	Crude.	
	Koku.	*Barrels.*
1902	1,060,000	1,204,160
1903	1,065,116	1,209,971
1904	1,249,536	1,419,473
1905	1,296,482	1,472,804
1906	1,501,563	1,705,776
1907	1,755,464	1,994,207
1908	1,815,001	2,061,841
1909	1,657,036	1,882,393
1910	1,695,950	1,926,599
1911	1,458,860	1,657,265

[a] Exclusive of the island of Formosa.

1 koku=39.7 English gallons=47.46 United States gallons=1.136 United States barrels.

In the following table is given a statement of the production of petroleum in Japan, 1905–1911, by fields, as reported by the mining bureau of the department of agriculture and commerce, Tokyo:

Production of petroleum in Japan, 1905–1911, by fields.

Field.	1905	1906	1907	1908
NIIGATA PREFECTURE.				
Echigo:	*Koku.*	*Koku.*	*Koku.*	*Koku.*
Higashiyama	273,844	304,847	342,042	263,66
Nishiyama	271,495	294,277	360,115	492,39
Niitsu	634,704	808,655	970,556	807,0
Kubiki	97,075	76,578	63,572	62,9
Amaze	5,220	7,262	12,447	....
Ojiya	14,180	9,964	6,732	7,0
Others (except Formosa)	....	....	....	6,4
Total quantity	1,296,482	1,501,563	1,755,464	1,639,5
Total value	....	....	....	$3,225,1

Field.	1909	1910	1911
	Koku.	*Koku.*	*Koku.*
Akita	3,194	12,924	23,1
Hokkaido	2,169	1,892	1,3
Nagano	64	61	....
Niigata	1,648,678	1,678,301	1,431,9
Shizuoka	2,931	2,637	....
Yamagata	....	135	....
Enshyu	....	....	2,4
Total	1,657,036	1,695,950	1,458,8
Formosa	5,664	3,208	1,4
Total	1,662,700	1,699,158	1,460,3

Production of petroleum in Japan and Formosa, 1906–1911.

Year.	Japan.		Formosa.		Total.	
	Koku.	*Barrels.*	*Koku.*	*Barrels.*	*Koku.*	*Barrels.*
06	1,501,563	1,705,776	4,394	4,992	1,505,957	1,710,768
07	1,755,464	1,994,207	[a]6,717	7,631	1,762,181	2,001,838
08	1,815,001	2,061,841	7,310	8,304	1,822,311	2,070,145
09	1,657,036	1,882,393	5,664	7,170	1,662,700	1,889.563
10	1,695,950	1,926,599	3,208	4,062	1,699,158	1,930,661
11	1,458,860	1,657,265	1,442	1,638	1,460,302	1,658,903

[a] Estimated.

PROSPECTING IN OTHER COUNTRIES.

Madagascar.—In Madagascar oil is reported as actually obtained n the west side 70 miles from the port of Maintirano. The Mada-ascar Oil Development Co. (Ltd.) found several oil sands in the rst 1,000 feet and is going deeper. The best yield was a thick oil t 530 feet. This well is in the Sakalava Valley, 7 or 8 miles south-est of Folakara.

Honduras.—As the result of discoveries made four years ago in onduras of a long outcrop of bituminous limestone carrying oil, in e Guare Mountains, Department of Comayagua, land has been enounced and a company formed for exploring for oil.

Timor.—The Timor Petroleum Concessions Co. and other conces-ions are exploring the indications of oil on Timor Island with a view furnishing fuel to North Australia.

Cuba.—During 1911 drilling for oil was carried on in Cuba at Mariel, suburb of Havana. The drilling was prompted by the occurrence f oil seepages in connection with large deposits of asphalt which ave been worked in that vicinity.

In the Province of Matanzas drilling was also in progress near eepages which have been known for many years and in fact have een exploited to a small extent in previous years. Other drilling as been projected, but not yet carried out, in the neighborhood of otembo, in Santa Clara Province.

WORLD'S PRODUCTION.

RANK OF COUNTRIES.

The world's production of petroleum has increased each year ince 1906, when the total was 212,912,860 barrels, to 345,512,185 arrels in 1911. Of this the United States contributes 63.80 per ent, or nearly two-thirds. Russia's percentage has fallen to 19.16, nd Mexico now appears as third in rank, taking the place of Galicia, hich now drops to sixth, and this order is likely to be maintained 1912, with an additional gain from Mexico. No other country is kely to produce more than 4 per cent of the total supply, which robably will not increase beyond the present total.

PRODUCTION.

The following table shows the world's production for 1911 in barrels and metric tons and for the years 1907 to 1910, inclusive, in barrels:

World's production of crude petroleum, 1906–1911, by countries, in barrels and metric tons.

Country.	1907	1908	1909	1910	1911			
					Rank.	Barrels.	Metric tons.	Per- cent of total produc- tion.
United States	166,095,335	178,527,355	183,170,874	209,557,248	1	220,449,391	29,393,252	63.80
Russia	61,850,734	62,186,447	65,970,350	70,336,574	2	66,183,691	9,066,259	19.16
Mexico	1,000,000	3,481,410	2,488,742	3,332,807	3	14,051,643	1,873,552	4.07
Dutch East Indies	9,982,597	10,283,357	11,041,852	11,030,620	4	12,172,949	1,670,668	3.52
Roumania	8,118,207	8,252,157	9,327,278	9,723,806	5	11,101,878	1,544,072	3.21
Galicia	8,455,841	12,612,295	14,932,799	12,673,688	6	10,485,726	1,458,275	3.04
India	4,344,162	5,047,038	6,676,517	6,137,990	7	6,451,203	897,184	1.87
Japan	2,010,639	2,070,145	1,889,563	1,930,661	8	1,658,903	221,187	.48
Peru	756,226	1,011,180	1,316,118	1,330,105	9	1,398,036	186,405	.4
Germany	756,631	1,009,278	1,018,837	1,032,522	10	995,764	140,000	.2
Canada	788,872	527,987	420,755	315,895	11	291,096	38,813	.0
Italy	59,875	50,966	42,388	42,388	12	a 71,905	10,000	.0
Other	a 30,000	a 30,000	a 30,000	a 30,000	....	a 200,000	26,667	.0
Total	264,249,119	285,089,615	298,326,073	327,474,304	....	345,512,185	46,526,334	100.0

a Estimated.

INTERNATIONAL PETROLEUM TESTS.

In January 1912, the second meeting was held by the Internationa Commission appointed by the Third International Congress of Petroleum to endeavor to effect international uniformity in the method of testing petroleum. The meeting was held in Vienna and wa attended by representatives from about 15 nations. Only a few delegates authorized by the several governments were present. I was evident from the beginning of the meeting that the disparity in the methods of testing petroleum products was too great to effec international uniformity at this time for the principal tests, an after expressing the views of the majority in regard to the forms o apparatus for determining flash points and other important properties of oils and suggesting their adoption in various countries, th commission proceeded to extend its field of work to all problem connected with the subject of petroleum and even changed the nam of the organization to the International Petroleum Commission Many important tests were made the subjects for work of subcommittees appointed by the main bodies to report at anothe meeting which will probably be held by the Eighth Internationa Congress of Applied Chemistry in Washington and New York i September, 1912, at which time it is hoped that copies of recommendations of the Vienna meeting may be printed and ready for distribution to those interested. When printed, it will be possible to hav access to these recommendations by application to Irving C. Allen Bureau of Mines, Pittsburgh, Pa., or to David T. Day, United State Geological Survey, Washington, D. C., who represented the Government of the United States at the Vienna meeting.

UNITED STATES GEOLOGICAL SURVEY PUBLICATIONS, 1901-1911, ON THE OIL FIELDS OF THE UNITED STATES.

The following publications of the United States Geological Survey refer to the oil fields of the United States; the later papers supplement the general description of the oil and gas fields given in these reports for 1907 and 1908:

PROFESSIONAL PAPERS.

56. Geography and geology of a portion of southwestern Wyoming, with special reference to coal and oil, by A. C. Veatch. 1907. 178 pp., 26 pls.
65. Geology and water resources of the northern portion of the Black Hills and adjoining regions in South Dakota and Wyoming, by N. H. Darton. 1909. 105 pp., 24 pls.

BULLETINS.

[a] 184. Oil and gas fields of the western interior and northern Texas coal measures and of the Upper Cretaceous and Tertiary of the western Gulf coast, by George I. Adams. 1901. 64 pp., 10 pls. 50c.

[a] 198. The Berea grit oil sand in the Cadiz quadrangle, Ohio, by W. T. Griswold. 1902. 43 pp., 1 pl. 10c.

[a] 212. Oil fields of the Texas-Louisiana Gulf Coastal Plain, by C. W. Hayes and William Kennedy. 1903. 174 pp., 11 pls. 20c.

[a] 213. Contributions to economic geology. 1902; S. F. Emmons and C. W. Hayes, geologists in charge. 1903. 449 pp. 25c.
  The petroleum fields of California, by George H. Eldridge, p. 306.
  The Boulder, Colo., oil field, by N. M. Fenneman, p. 322.
  Asphalt, oil, and gas in southwestern Indiana, by Myron L. Fuller, p. 333.
  Structural work during 1901 and 1902 in the eastern Ohio oil fields, by W. T. Griswold, p. 336.
  Oil fields of the Texas-Louisiana Gulf Coastal Plain, by C. W. Hayes, p. 345.

[a] 225. Contributions to economic geology, 1903; S. F. Emmons and C. W. Hayes, geologists in charge. 1904. 527 pp., 1 pl. 35c.
  Petroleum fields of Alaska and the Bering River coal field, by G. C. Martin, p. 365.
  Structure of the Boulder oil field, Colorado, with records for the year 1903, by N. M. Fenneman, p. 383.
  The Hyner gas pool, Pennsylvania, by M. L. Fuller, p. 392.
  Oil and gas fields of eastern Greene County, Pa., by Ralph W. Stone, p. 396.

[a] 238. Economic geology of the Iola quadrangle, Kansas, by G. I. Adams, Erasmus Haworth, and W. R. Crane. 1904. 83 pp., 11 pls. 25c.

250. The petroleum fields of the Pacific coast of Alaska, with an account of the Bering River coal deposits, by G. C. Martin. 1905. 64 pp., 7 pls.

256. Mineral resources of the Elders ridge quadrangle, Pennsylvania, by R. W. Stone. 1905. 86 pp., 12 pls.

[a] 259. Report on progress of investigations of mineral resources of Alaska in 1904, by A. H. Brooks and others. 1905. 196 pp., 3 pls. 15c.

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[a] Geological Survey's stock of the paper is exhausted, but many of the papers marked in this way may be purchased from the Superintendent of Documents, Washington, D. C., at the prices indicated.

[a] 260. Contributions to economic geology, 1904; by S. F. Emmons and C. W. Hayes, geologists in charge. 1905. 620 pp., 4 pls. 40c.

The Florence, Colo., oil field, by N. M. Fenneman, p. 436.

Notes on the geology of the Muscogee oil field, Oklahoma, by J. A. Taff and M. K. Shaler, p. 441.

Oil and gas in the Independence quadrangle, Kansas, by F. C. Schrader and Erasmus Haworth, p. 446.

Oil fields of the Texas-Louisiana Gulf coast, by N. M. Fenneman, p. 459.

Oil and asphalt prospects in Salt Lake Basin, Utah, by J. M. Boutwell, p. 468.

264. Record of deep-well drilling for 1904, by M. L. Fuller, E. F. Lines, and A. C. Veatch. 1905. 106 pp.

265. Geology of the Boulder district, Colorado, by N. M. Fenneman. 1905. 101 pp., 5 pls.

279. Mineral resources of the Kittanning and Rural Valley quadrangles, Pennsylvania, by Charles Butts. 1906. 198 pp., 11 pls.

[a] 282. Oil fields of the Texas-Louisiana Gulf Coastal Plain, by N. M. Fenneman. 1906. 146 pp., 11 pls. 20c.

[a] 285. Contributions to economic geology, 1905; S. F. Emmons and E. C. Eckel, geologists in charge. 1906. 506 pp., 13 pls. 60c.

The Salt Lake oil field near Los Angeles, Cal., by Ralph Arnold, p. 357.

The Nineveh and Gordon oil sands in western Greene County, Pa., by F. G. Clapp, p. 362.

286. Economic geology of the Beaver quadrangle, Pennsylvania, by L. H. Woolsey. 1906. 132 pp., 8 pls.

296. Economic geology of the Independence quadrangle, Kansas, by F. C. Schrader and Erasmus Haworth. 1906. 74 pp., 6 pls.

[a] 298. Record of deep-well drilling for 1905, by Myron L. Fuller and Samuel Sanford. 1906. 299 pp. 25c.

300. Economic geology of the Amity quadrangle in eastern Washington County, Pa., by F. G. Clapp. 1907. 145 pp., 8 pls.

[a] 304. Oil and gas fields of Greene County, Pa., by R. W. Stone and F. G. Clapp. 1907. 110 pp., 3 pls. 45c.

[a] 309. The Santa Clara Valley, Puente Hills, and Los Angeles oil districts, southern California, by G. H. Eldridge and Ralph Arnold. 1907. 266 pp., 41 pls. 80c.

314. Report on progress of investigations of mineral resources of Alaska in 1906, by A. H. Brooks and others. 1907. 235 pp., 4 pls.

[a] 317. Preliminary report on the Santa Maria oil district, Santa Barbara County, Cal., by Ralph Arnold and Robert Anderson. 1907. 69 pp., 2 pls. 15c.

[a] 318. Geology of oil and gas fields in Steubenville, Burgettstown, and Claysville quadrangles, Ohio, West Virginia, and Pennsylvania, by W. T. Griswold and M. J. Munn. 1907. 196 pp., 13 pls. 75c.

[a] 321. Geology and oil resources of the Summerland district, Santa Barbara County Cal., by Ralph Arnold. 1907. 91 pp., 20 pls. 25c.

[a] 322. Geology and oil resources of the Santa Maria oil district, Santa Barbara County Cal., by Ralph Arnold and Robert Anderson. 1907. 161 pp., 26 pls. 50c

330. The data of geochemistry, by F. W. Clarke. 1908. 716 pp.

335. Geology and mineral resources of the Controller Bay region, Alaska, by G. C Martin. 1908. 141 pp., 10 pls.

[a] 340. Contributions to economic geology, 1907, Part I: Metals and nonmetals excep fuels. C. W. Hayes, Waldemar Lindgren, geologists in charge. 1908. 48 pp., 6 pls. 30c.

Petroleum and natural gas—California: Contra Costa County, Mine ranch field, by Ralph Arnold. Utah: Southern Utah oil field, by G. B Richardson. Wyoming: Bighorn basin gas fields, by C. W. Washburne Uinta County, Labarge oil field, by A. R. Schultz, pp. 339–374.

346. Structure of the Berea oil sand in the Flushing quadrangle, Ohio, by W. T Griswold. 1908. 30 pp., 2 pls.

350. Geology of the Rangely oil district, Colorado, with a section on the wate supply, by H. S. Gale. 1908. 60 pp., 4 pls.

357. Preliminary report on the Coalinga oil district in Fresno and Kings Countie Cal., by Ralph Arnold and Robert Anderson. 1908. 142 pp., 2 pls.

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[a] Geological Survey's stock of the paper is exhausted, but many of the papers marked in this way ma be purchased from the Superintendent of Documents, Washington, D. C., at the prices indicated.

364. Geology and mineral resources of the Laramie basin, Wyoming, by N. H. Darton and C. E. Siebenthal. 1909. 81 pp., 8 pls.

365. The fractionation of crude petroleum by capillary diffusion, by J. E. Gilpin and M. P. Cram. 1908. 33 pp.

381. Contributions to economic geology, 1908, Part II: Mineral fuels. M. R. Campbell, geologist in charge. 1910. 599 pp., 24 pls.

Geology and oil prospects of the Reno region, Nevada, by R. Anderson. Two areas of oil prospecting in Lyon County, western Nevada, by R. Anderson. Analyses of crude petroleum from Oklahoma and Kansas, by D. T. Day. The Madill oil pool, Oklahoma, by J. A. Taff and W. J. Reed. Development in the Boulder and Florence oil fields, Colorado, by C. W. Washburne, pp. 475-544.

394. Papers on the conservation of mineral resources. 1909. 214 pp., 12 pls.

[a]398. Geology and oil resources of the Coalinga district, California, final report, by Ralph Arnold and Robert Anderson. 85c.

401. Relations between local magnetic disturbances and the genesis of petroleum, by George F. Becker. 1909. 24 pp.

406. Preliminary report on the McKittrick-Sunset oil region, Kern and San Luis Obispo Counties, California, by Ralph Arnold and Harry R. Johnson. 225 pp., 5 pls.

415. Coal fields of northwestern Colorado and northeastern Utah, by Hoyt S. Gale. 1910. 265 pp., 22 pls.

429. Oil and gas in Louisiana, with a brief summary of their occurrence in adjacent States, by G. D. Harris. 1910. 192 pp., 22 pls.

431. Contributions to economic geology, 1909, Part II: Mineral fuels. M. R. Campbell, geologist in charge.

Natural gas in North Dakota, by A. G. Leonard. The San Juan oil field, Utah, by H. E. Gregory. Gas and oil prospects near Vale, Oreg., and Payette, Idaho, by C. W. Washburne. Gas prospects in the Harney Valley, Oregon, by C. W. Washburne. Preliminary report on the geology and oil prospects of the Cantua-Panoche region, California, by Robert Anderson.

450. Mineral resources of the Llano-Burnet region, Texas, with an account of the pre-Cambrian geology, by Sidney Paige. 1911. 103 pp., 5 pls.

452. The Lander and Salt Creek oil fields, Wyoming. The Lander oil field, Fremont County, by E. G. Woodruff; The Salt Creek oil field, Natrona County, by C. H. Wegemann. 1911. 87 pp., 12 pls.

454. Coal, oil, and gas of the Foxburg quadrangle, Pennsylvania, by E. W. Shaw and M. J. Munn. 1911. 85 pp., 10 pls.

456. Geology of the oil and gas fields of the Carnegie quadrangle, Pennsylvania, by M. J. Munn. 1911. 99 pp., 5 pls.

471. Contributions to economic geology (short papers and preliminary reports), 1910. Part II: Mineral fuels. M. R. Campbell, geologist in charge.

475. Diffusion of petroleum through fuller's earth, by J. Elliott Gilpin and O. E. Bransky.

IN PREPARATION.

—. Geology and geography of a portion of central Uinta County, Wyoming, by A. R. Schultz.

WATER-SUPPLY PAPER.

113. The disposal of strawboard and oil-well wastes, by R. L. Sackett and Isaiah Bowman. 1905. 52 pp., 4 pls.

FOLIOS OF THE GEOLOGIC ATLAS OF THE UNITED STATES CONCERNING PETROLEUM AND NATURAL-GAS FIELDS, 1897–1911.

40. Wartburg, Tenn., by A. Keith. 1897.
53. Standingstone, Tenn., by M. R. Campbell. 1899.
72. Charleston, W. Va., by M. R. Campbell. 1901.
76. Austin, Tex., by R. T. Hill and T. W. Vaughan. 1902.
82. Masontown-Uniontown, Pa., by M. R. Campbell. 1902.
92. Gaines, Pa.-N. Y., by M. L. Fuller and W. C. Alden. 1903.
105. Patoka, Ind.-Ill., by M. L. Fuller and F. G. Clapp. 1904.
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146. Rogersville, Pa., by F. G. Clapp. 1907.
[a] 148. Joplin district, Mo.-Kans., by W. S. T. Smith and C. E. Siebenthal. 1907.
159. Independence, Kans., by F. C. Schrader. 1908.
163. Santa Cruz, Cal., by J. C. Branner, J. F. Newsome, and R. Arnold. 1909.
[b] 165. Aberdeen-Redfield, S. Dak., by J. E. Todd. 1909.
[b] 172. Warren, Pa.-N. Y., by C. Butts. 1910.
[b] 176. Sewickley, Pa., by M. J. Munn. 1911.
[b] 177. Burgettstown-Carnegie, Pa., by E. W. Shaw and M. J. Munn. 1911.
[b] 178. Foxburg-Clarion, Pa., by E. W. Shaw, E. F. Lines, and M. J. Munn. 1911.
[b] 180. Claysville, Pa., by M. J. Munn. 1911.

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[a] The price of folio No. 148 is 50 cents. The other folios named are sold at 25 cents each.

[b] Issued in two editions—library (18 by 22 inches) and field (6 by 9 inches). Specify edition desired. The field edition costs 25 cents more than the library edition.

PEAT.

By Charles A. Davis.

PRODUCTION.

FUEL.

In the United States no progress can be reported in the actual production of peat fuel. So far as could be learned, but two small peat-fuel plants, making machine peat, were in operation in the country in 1911 for a part of the time only and with small total output. One of these plants was at Kalamazoo, Mich., and the other near Fertile, Iowa. Both were equipped with German peat presses or macerating machines and each made air-dried peat bricks averaging from 1 to 2 pounds in weight. The output at each plant averaged from 10 to 20 tons of salable peat fuel per day. The total output was reported at about 300 short tons; sales were reported at $5 per ton. There was a small experimental peat-fuel plant in use for a short time near Toledo, Ohio, but no commercial production was reported from it.

PEAT COKE OR CHARCOAL.

For a part of the season of 1911 a small plant for making peat coke was in operation in Connecticut. The plant was not fully completed, but produced about 25 tons of coke, valued at $350. The use of peat coke is reported to be on the increase in Europe as a substitute for wood charcoal in metallurgical and other processes in which fuel free from sulphur is required. The increased cost and inferior quality of much of the wood charcoal now furnished to American consumers should make possible the sale of a good quality of peat coke in the United States.

The peat briquetting plant at Lakeville, Ind., was reported in September to be closed indefinitely and to have made no production during the season.

Late in the year 1911 a powerful English company, controlled by the chief stockholders of a large corporation manufacturing gas producers, was formed, as announced in the public press, for the purpose of developing power and ammonia-recovery plants for utilizing low-grade fuels in various countries. One of the districts mentioned is Florida. At about the same time a large tract of peat land was acquired between Jacksonville and St. Augustine in that State to be used as a source of fuel.

FERTILIZER AND FERTILIZER FILLERS.

The production of dried peat for use as fertilizer showed a steady increase in total tonnage in 1911 in spite of bad weather, from which most of the producers suffered and which materially increased the cost of production. Heavy rainfall during the summer and autumn made air drying on the collecting areas very uncertain and also increased the quantity of water in the ground, so that digging, transporting, and drying the raw material were much more difficult and expensive than usual.

During 1911, 12 firms were engaged more or less extensively in preparing peat for fertilizer. Some of the producers reported a very small output for the use of florists and other horticulturists only, the total quantity for this trade being small. One firm of the 12 was reconstructing its plant and reported no commercial production.

Distribution of plants.—Black and thoroughly decomposed peat is most satisfactory for making fertilizer; brown and fibrous peat is less easily reduced to powder and mixes less readily with other ingredients used in making artificial fertilizers. Therefore the States in which black peats are most common are the largest producers. The factories actively engaged in preparing peat for fertilizer in 1911 were in in the States named below: Connecticut, 1; Florida, 1; Illinois, 1; Indiana, 2; New Jersey, 2; New York, 3; Pennsylvania, 1; Ohio, 1.

No noteworthy changes were made in methods of preparing pea for market, but at one plant a suction-pump dredge was installed t excavate and pump the peat to the drying grounds. This method of handling the raw material was very satisfactory, so far as cost and quantity of raw material gathered were concerned, but mor water was required to keep the dredge working continuously tha could be obtained from the excavations, as the water found its wa back to the bog very slowly from the drying ground. The princip of the suction dredge seems applicable to excavating peat from un drained bogs where large quantities of water are available, but ap parently is not adapted to those where free water is not in excess.

Grades of the product.—As in former years the peat was prepare and sold for fertilizer uses in two different grades—"bone dry" an "sun dry." Bone-dry peat has been dried by artificial heat in rotar driers until it contains only about 10 per cent of moisture and ha been screened to a powder of fairly uniform size. Sun-dry peat i as the name suggests, peat that has been dried by exposure to th sun and air and by stirring and harrowing it during the drying pro ess. Its moisture content is variable and it is sold almost entirely furnish organic matter for soil improvement in various horticultur operations. For these uses the demand is constantly growing.

Output and sales during 1911.—A total production of 51,733 to of peat for fertilizer and fertilizer filler was reported for 1911, but th production does not include the output of two firms from whom reports could be obtained. The average selling price was slight less than $5 per ton, and sales amounting to $257,204 were reporte

PEAT FOR OTHER COMMERCIAL PURPOSES.

Food for stock.—In 1911 there was a growing consumption of pe for miscellaneous uses, the most important of which seems to ha been as an absorbent for refuse beet sugar and other molasses, so th hese excellent food materials can be used to feed economically to :attle and other live stock. Charred dried peat is also used in poul-ry and other commercial foods for stock.

The total consumption of peat reported for these purposes was ,995 tons, valued at $12,735.

Paper-stock manufacturing.—A single paper factory built for mak-ng peat paper reported using 500 tons of peat in 1911. This repre-ented the consumption for but a single month, as the plant was not ompleted until late in the year. No valuation was given the peat y the producer.

Refrigeration.—For use in refrigeration one firm reported shipping bout 500 tons of peat, valued at $375. The peat was dried before eing used and was mixed with mineral matter. It serves to absorb waterproofing substance.

Mud baths.—One producer of dried peat states that from 75 to 100 ons of dried peat are shipped annually from his factory for use in nud baths for the treatment of rheumatism and other diseases.

PEAT STABLE LITTER.

No peat moss stable litter is known to have been produced in the Jnited States in 1911, although a considerable quantity is annually mported into the seacoast cities of this country from Holland and Germany. The use of this material continues to increase abroad, oth for stock bedding and for packing material.

The imports into the United States for the year 1911 were 9,022 hort tons (8,056 long tons), valued at $39,372. This quantity was slight increase over that imported in 1910, and the value was some-vhat less.

CONSUMPTION.

The total production and consumption of peat for all purposes in the United States for 1911 is, so far as reported, shown in the fol-owing table:

Production and consumption of peat in the United States in 1911, in short tons.

Use.	Production.		Imports.		Total.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
uel: Machine peat	290	$1,450			290	$1,450
Peat coke	25	350			25	350
ertilizer	51,733	257,204			51,733	257,204
table litter			9,022	$39,372	9,022	39,372
tock food	1,995	12,735			1,995	12,735
efrigeration	500	375			500	375
aper	[a] 500				500	
ud baths	[a] 100				100	
Total	55,143	272,114	9,022	39,372	64,165	311,486

[a] Value not given.

NOTES ON PEAT INDUSTRY IN EUROPE.

Use of peat fuel for generating power.—The use of peat fuel for generating power seems to be steadily increasing in those European countries where workable peat beds occur. During 1911 detailed reports have been received of the successful commercial operation, with only peat for fuel, of large electric power stations in Germany, Sweden, and Italy, and of smaller producer-gas-engine installations generating power for factories in Ireland, Russia, and England.

The most notable achievement in the use of peat fuel is the reported successful commercial adaptation of the by-products recovery gas producer to the use of peat with the relatively high water content of 50 to 70 per cent, so that not only a usable power gas can be obtained from it, but also from 70 to 85 per cent of the combined nitrogen of the peat may be recovered as ammonium sulphate, a product which always finds ready sale as a fertilizer. The largest plant of this type yet built is the electric power station at the Sweger Moor, near Osnabrück, in northwestern Germany. This plant was first put into actual commercial operation late in 1911, and during November it was reported to have furnished 428,870 kilowatt hours of electric current to consumers. In addition, during the six weeks ending about December 1 about 20 metric tons of ammonium sulphate were recovered as a by-product.

Preparation of peat fuel for gas producers in Europe.—Careful inquiry and the examination of many reports on the subject fail to show that any attempt has been made in Europe to standardize the methods of preparing peat for use in gas producers. As far as can be learned, each of the plants using peat fuel avails itself of the methods of digging the peat, shaping it into blocks, and drying and storing it that are usual in the locality where the plant is situated and that time and custom have developed. At one plant the peat is cut into blocks by hand as it is dug, then air dried, and stacked until used. Generally, however, some system of machinery is used, at least for part of the work of getting the peat ready for the gas producer. The processes could and doubtless will be cheapened, but the results of the use of the fuel seem satisfactory whatever the method of preparation.

CEMENT.

By E. F. Burchard.

INTRODUCTION.

On February 8, 1912, the preliminary estimate of Portland cement production for the calendar year 1911 was released to the press by the United States Geological Survey. So early a compilation of these figures was rendered possible only through the hearty cooperation of the majority of the manufacturers. It was stated at that time that there was apparently a slight increase over the production of Portland cement in 1910. Complete returns confirm this statement and show that the preliminary estimate was within 0.83 per cent of the exact total quantity, thus demonstrating the practical value to the industry of an early preliminary estimate made on the basis of that for 1911. The preliminary estimate could not give consideration to the comparatively small production of natural and puzzolan cements, but these are treated in full in the present chapter.

In the chapter on the cement industry in 1910[1] a summary was given of the resources of the United States in limestone, marl, shale, and clay suitable for making Portland cement. A map accompanied that chapter, a large edition of which was printed, and copies are still available for free distribution; consequently the supplies of raw materials need not be reviewed here.

PRODUCTION OF ALL CEMENTS.

The total quantity of Portland, natural, and puzzolan cement produced in the United States during 1911 was 79,547,958 barrels, valued at $66,705,136. As compared with 1910, when the production was 77,785,141 barrels, valued at $68,752,092, the year 1911 showed an increase of 1,762,817 barrels, or 2.27 per cent, in quantity, but a decrease of $2,046,956, or 2.98 per cent, in value. The increase in quantity is the smallest recorded within the last 13 years, and the fact that the total value showed an actual decrease indicates that trade conditions were not as satisfactory in 1911 as in 1910. The distribution of the total production among the three main classes of cement is shown in the following table. For comparison the figures for 1909 and 1910 are also presented.

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[1] Burchard, E. F., Cement: Mineral Resources U. S. for 1910, pt. 2, U. S. Geol. Survey, 1911, pp. 488–532.

Total production of cement in the United States in 1909, 1910, and 1911, by classes.

Class.	1909		1910		1911	
	Quantity (barrels).	Value.	Quantity (barrels).	Value.	Quantity (barrels).	Value.
Portland	64,991,431	$52,858,354	76,549,951	$68,205,800	78,528,637	$66,248,817
Natural	1,537,638	652,756	1,139,239	483,006	926,091	378,533
Puzzolan	160,646	99,453	95,951	63,286	93,230	77,786
Total	66,689,715	53,610,563	77,785,141	68,752,092	79,547,958	66,705,136

PORTLAND CEMENT.

PRODUCTION.

The total production of Portland cement in the United States in 1911, as reported to the United States Geological Survey, was 78,528,637 barrels, valued at $66,248,817. It is interesting to note that this quantity reduced to tons is equivalent to 13,321,822 long tons, valued at $4.97 per ton. As compared with the pig-iron output for 1911, which was 23,257,288 long tons, having a value of $327,334,624, or $14.07 per ton, the Portland cement production approximates 57.28 per cent of the quantity of pig iron, and 20.24 per cent of its value. As compared with the production of Portland cement for 1910, which was 76,549,951 barrels, valued at $68,205,800, the output for 1911 represents an increase in quantity of 1,978,686 barrels, or 2.58 per cent, and a decrease in value of $1,956,983, or 2.87 per cent. The average price per barrel in 1911, according to the figures reported to the Survey, was a trifle less than 84.4 cents, as compared with 89.1 cents in 1910. This represents the value of the cement in bulk at the mills, including the labor cost of packing, but not the value of the sacks or barrels. This average price per barrel is about 12.9 cents higher than the average price received for Portland cement in the Lehigh district, and is a little higher than the average prices received in New York and Michigan, while it falls 34.2 cents below the average price received in the Rocky Mountain States, and 56.2 cents below that received in the Pacific coast district. In the average price for the country is included the value of 135,775 barrels of white Portland cement, which sold at an average price of about $2.50 per barrel.

STOCKS AND SHIPMENTS.

Reports were received from 105 out of 115 producing plants, giving the stocks of Portland cement on hand December 31, 1911. The quantity reported aggregated 15.2 per cent of the total production of the 105 reporting plants. Estimated proportionately for the whole number of producing plants, a total of 11,936,353 barrels represents the stocks of finished Portland cement on hand at the mills at the close of 1911. The incompleteness of the reports makes it inadvisable to attempt to distribute these stocks by States or commercial districts in the present report.

An estimate has also been made of shipments from all producing mills in 1911. This estimate gives a total of approximately 76,567,44 barrels of Portland cement shipped during 1911. An approximate estimate of the total consumption of Portland cement in the United States in 1911 might be made as follows: To the shipments add the imports, 164,670 barrels, and from the sum, which represents the total available supply, 76,732,111 barrels, subtract the exports, 3,135,409 barrels, which leaves 73,596,702 barrels as the apparent consumption. The data on which the figures for shipments are based are not satisfactory, and they are therefore presented subject to revision in the report for 1912. Beginning with the report for 1912 it is planned to change the basis of statistical statement from that of production to one based on shipments, in the belief that the latter basis will be of more practical value to the industry.

PRODUCTION BY STATES.

In the following table the Portland cement production is given by States, or by groups of States where there are less than three producers in a single State. By the term "producer" is meant a Portland cement manufacturing company, whether the company operates one or more plants. In the table the term "producing plant" is applied to a mill or group of mills located at one place and operated by one company, but each establishment at a different place is counted as a plant.

Production of Portland cement in the United States in 1910 and 1911, by States.

1910			
State.	Producing plants.	Quantity (barrels).	Value.
Pennsylvania	25	26,675,978	$19,551,268
Indiana	5	7,219,199	6,487,508
Kansas	11	5,655,808	5,359,408
California	7	6,385,588	8,843,210
Washington	2		
Illinois	5	4,459,450	4,119,012
Missouri	4	4,455,589	3,858,088
New Jersey	3	4,184,698	3,067,265
Michigan	12	3,687,719	3,378,940
New York	8	3,296,350	2,906,551
Texas	4	2,287,445	2,664,846
Oklahoma	2		
Iowa	2	2,010,379	1,986,694
Kentucky	1		
West Virginia	1		
Ohio	5	1,527,670	1,279,717
Alabama	2	1,481,359	1,323,495
Georgia	1		
Tennessee	1		
Maryland	1	1,206,158	830,218
Virginia	2		
Arizona	1	1,204,761	1,543,620
Colorado	2		
Montana	1		
Utah	3	811,800	1,005,960
Total	111	76,549,951	68,205,800

1911			
State.	Producing plants.	Quantity (barrels).	Value.
Pennsylvania	25	26,864,679	$19,258,253
Indiana	5	7,407,830	5,937,241
California	8	6,317,701	8,737,150
Kansas	12	4,871,903	3,725,108
Illinois	5	4,582,341	3,583,301
New Jersey	3	4,411,890	3,259,528
Missouri	4	4,114,859	3,349,312
Michigan	11	3,686,716	3,024,676
New York	7	3,314,217	2,669,194
Iowa	3	1,952,590	1,881,253
Ohio	5	1,451,852	1,228,680
Washington	3	960,573	1,496,807
Utah	3	662,849	827,523
Texas	4	2,438,493	2,541,449
Oklahoma	2		
Tennessee	2	1,981,341	1,590,438
West Virginia	1		
Kentucky	1		
Virginia	2	1,487,753	1,084,315
Maryland	2		
Colorado	2	1,162,081	1,272,317
Montana	1		
Alabama	2	858,969	782,272
Georgia	2		
Total	115	78,528,637	66,248,817

PRODUCTION BY COMMERCIAL DISTRICTS.

In place of the five geographic districts formerly considered by the Survey, the United States has been divided into 11 subdivisions based on the grouping of plants in direct relation to the trade territory covered by each group. (See Pl. I.) This grouping is also more logical when the raw materials are considered. The plants in northeastern Indiana and northern Kentucky, all of which are near Ohio River and all of which use hard limestone, are grouped together. Plants near Chicago, whether in Illinois or Indiana, are logically grouped together because of their nearly equal freight rates. The Southeastern States, in which plants use mostly Appalachian limestone, are grouped together, and central Texas has been transferred to the group of Great Plains States, to which it more logically belongs. Plants between Missouri River and Mississippi River in Missouri and Iowa are grouped together, and the plants in the Rocky Mountain States and western Texas are considered in a group intermediate between the Great Plains and the Pacific coast. The following table summarizes the statistics for 1910 and 1911 for each district with regard to the number of active plants, the total production in 1910 and 1911, the percentage of gain and loss in 1911, and the average price per barrel.

Production of Portland cement in 1910 and 1911, by commercial districts.

District.	Active plants.		Production.		Change.	Average factory price per barrel.	
	1910	1911	1910	1911	1911	1910	1911
			Barrels.	*Barrels.*	*Per cent.*		
New Jersey and eastern Pennsylvania (Lehigh district)	24	24	26,315,359	25,972,108	— 1.30	$0.729	$0.715
New York	8	7	3,296,350	3,314,217	+ .54	.882	.805
Ohio and western Pennsylvania	9	9	6,072,987	6,756,313	+11.25	.776	.766
Michigan and northeastern Indiana	14	13	4,524,591	4,519,726	— .11	.921	.827
Kentucky and southern Indiana	3	3	2,824,832	2,818,820	— .21	.799	.793
Illinois and northwestern Indiana	6	6	8,376,450	8,617,341	+ 2.88	.940	.791
Southeastern States (Maryland, Virginia, West Virginia, Tennessee, Georgia, and Alabama)	8	11	3,071,009	4,049,063	+31.85	.794	.793
Iowa and Missouri	6	7	5,722,971	6,067,449	+ 6.02	.916	.862
Great Plains States (Kansas, Oklahoma, and Central Texas)	16	17	7,723,253	7,010,396	— 9.23	.996	.834
Rocky Mountain States (Colorado, Utah, Montana, Arizona, and Western Texas)	8	7	2,236,561	2,124,930	— 4.99	1.288	1.186
Pacific coast States (California and Washington)	9	11	6,385,588	7,278,274	+13.98	1.385	1.406
Total	111	115	76,549,951	78,528,637	+ 2.58	.891	.844

This table brings out some interesting facts concerning the year's output in the several districts. According to the returns received there were decreases in production in 1911 as compared with 1910 in the Lehigh, Michigan-northeastern Indiana, Kentucky-southern Indiana, Great Plains, and Rocky Mountain districts. The increases recorded in production were in the New York, Ohio-western Pennsylvania, Illinois-northwestern Indiana, Southeastern States, Iowa-Missouri, and Pacific coast districts. The greatest decrease in production was in the Great Plains district, which amounted to 9.23 per cent of the 1910 production. The greatest increase in production, 31.85 per cent, was recorded in the Southeastern States, and the Pacific coast showed a gain of nearly 14 per cent. These two large increases were due in large part to the starting of three new mills in the Southeastern and two new mills in the Pacific coast States.

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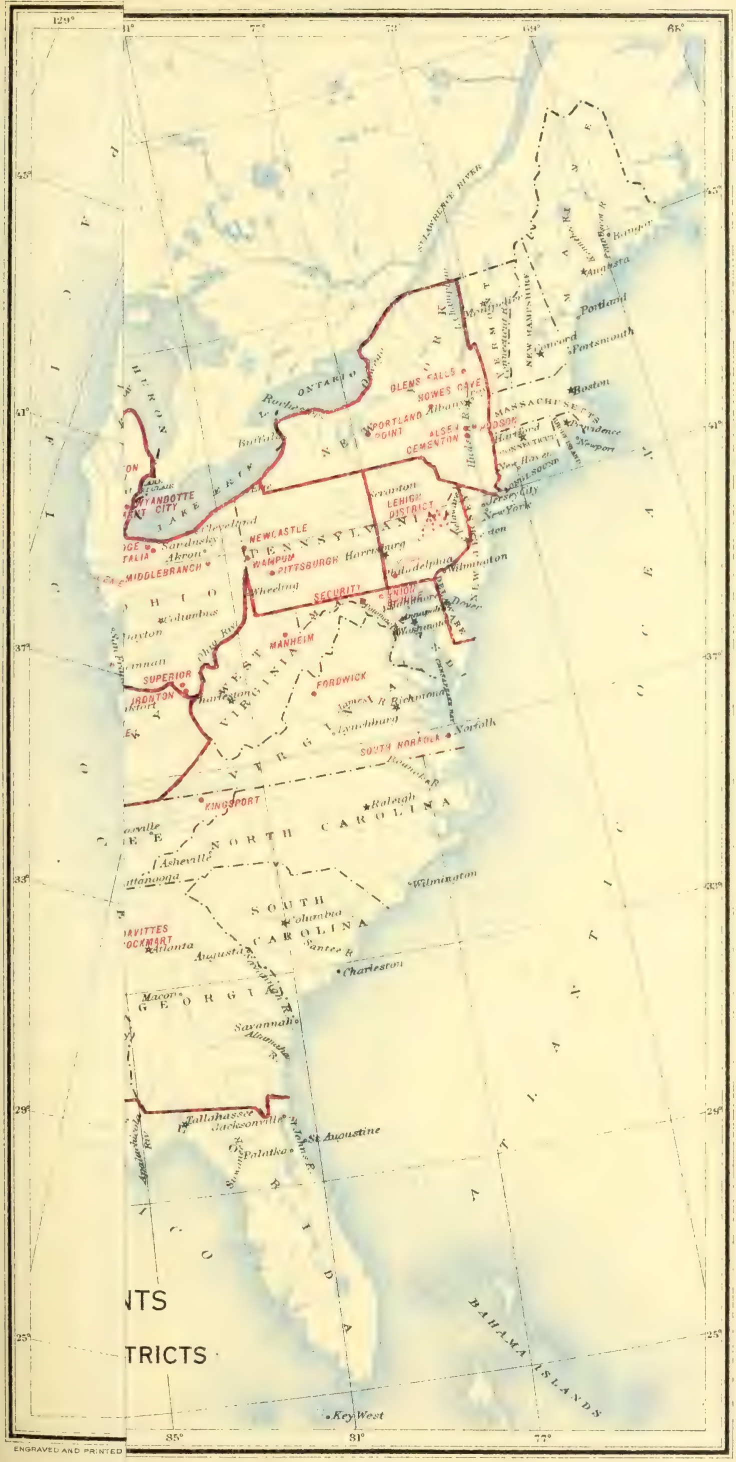
MINERAL RESOURCES 1911 PART II PLATE I



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GLENS FALLS
HOWES CAVE
PORTLAND POINT
ALSEN
CEMENTON
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MANHEIM
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Annapolis
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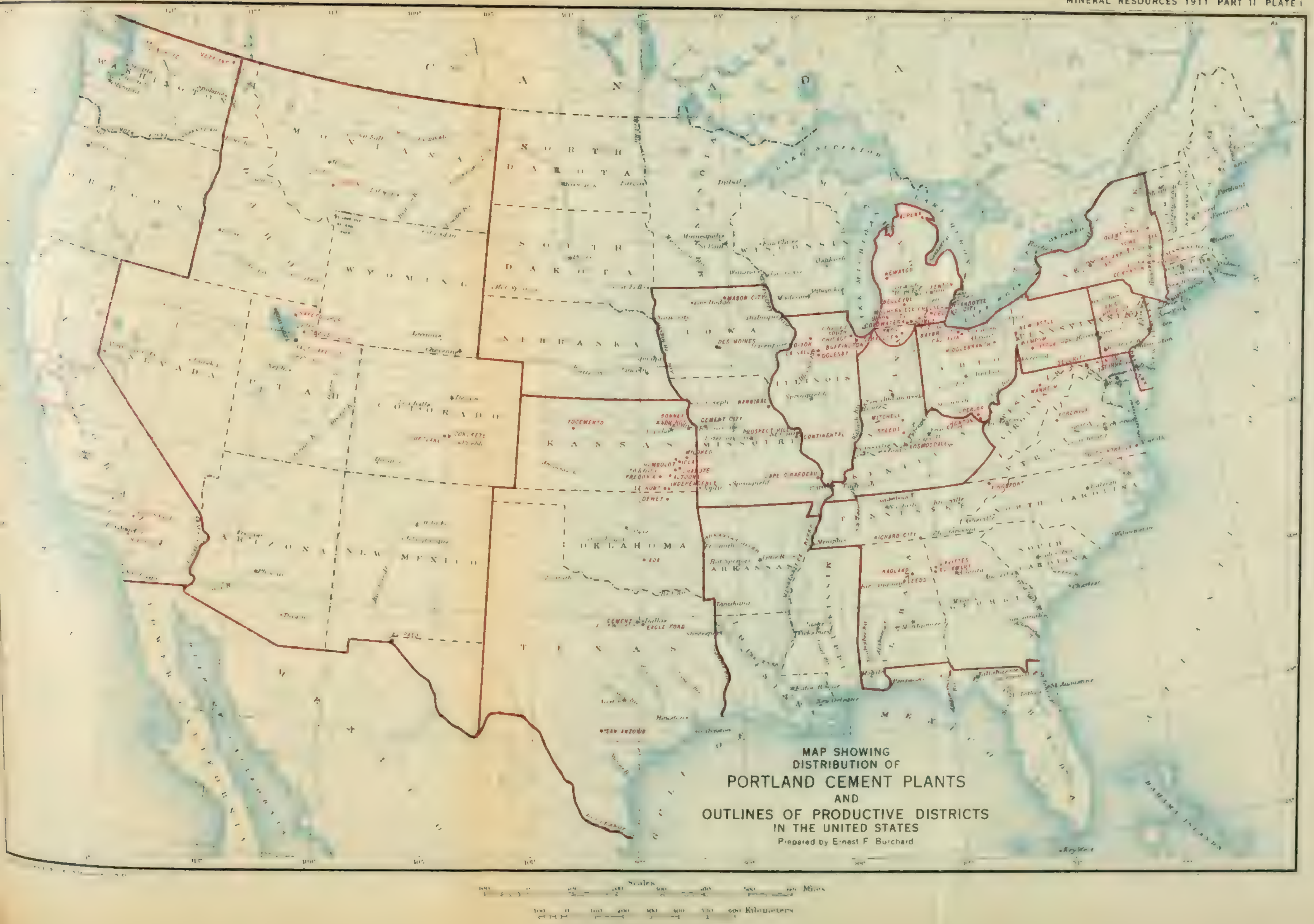
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MITCHELL
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MAP SHOWING
DISTRIBUTION OF
PORTLAND CEMENT PLANTS
AND
OUTLINES OF PRODUCTIVE DISTRICTS
IN THE UNITED STATES

Prepared by Ernest F. Burchard

1912

In contrast to the fluctuations in output the prices from 1910 to 1911 ran a more even course. The Survey has made every effort to obtain accurate statistics of prices of Portland cement averaged from the total sales for the year in bulk at the mills. When the preliminary estimate of production for 1911 was made, early in February, 1912, the apparent average price for the whole output in 1911 was placed at 86.7 cents per barrel, and that of the Lehigh district, the output of which is about 33 per cent of the output of the United States, was placed at 76.3 cents per barrel. Final returns gave an average price of 84.4 cents per barrel for the whole country, a reduction of 2.3 cents from the preliminary estimate, and 71.5 cents for the Lehigh district, a reduction of 4.8 cents per barrel, as compared with the preliminary estimate. This price is 1.4 cents lower than the average price per barrel reported in 1910 from the Lehigh district.

The Survey has tabulated the reported figures of production without change and submits them in the belief that they are as accurate as can be obtained.

THE LEHIGH DISTRICT.

The Lehigh district of eastern Pennsylvania-New Jersey has, with three exceptions, shown a steady increase in production each year from 1890 to the present time. The years in which slight decreases are recorded are 1893, 1908, and 1911. The first two decreases were coincident with years of general business depression, but the decrease in 1911 may perhaps be in large part attributed to an overproduction in 1910. The production for 1911 was 25,972,108 barrels, valued at $18,568,670, or 71.5 cents a barrel. This production represented a decrease in quantity of 343,251 barrels and in value of $619,845, as compared with the production of 1910, and an average decrease in price of 1.4 cents a barrel. The production of white Portland cement from three plants is included in the figures for 1911. There was no net gain or loss in the number of producing plants in the Lehigh district, but the starting of new plants in the South and West resulted in lowering once more the Lehigh district's proportion of the total output of cement in the United States.

The following table shows the annual production in the Lehigh district since 1890, the total production for the country, and the percentage of the Lehigh district output each year to the total production:

Portland cement production in the Lehigh district and in the United States, 1890–1911, in barrels.

Year.	Lehigh district output.	Total output, United States.	Percentage of total manufactured in Lehigh district.
1890	201,000	335,500	60.0
1891	248,500	454,813	54.7
1892	280,840	547,440	51.3
1893	265,317	590,652	44.9
1894	485,329	798,757	60.8
1895	634,276	990,324	64.0
1896	1,048,154	1,543,023	68.1
1897	2,002,059	2,677,775	74.8
1898	2,674,304	3,692,284	72.4
1899	4,110,132	5,652,266	72.7
1900	6,153,629	8,482,020	72.6
1901	8,595,340	12,711,225	67.7
1902	10,829,922	17,230,644	62.8
1903	12,324,922	22,342,973	55.2
1904	14,211,039	26,505,881	53.7
1905	17,368,687	35,246,812	49.3
1906	22,784,613	46,463,424	49.0
1907	24,417,686	48,785,390	50.0
1908	20,200,387	51,072,612	39.6
1909	24,246,706	64,991,431	37.3
1910	26,315,359	76,549,951	34.4
1911	25,972,108	78,528,637	33.1

PRODUCTION ACCORDING TO RAW MATERIALS.

In the following table the production of Portland cement in the United States is classified according to the kinds of raw materials from which the cement is manufactured. The production is grouped as follows:

Type 1 includes cement produced from a mixture of argillaceous limestone ("cement rock") and pure limestone. This is the combination of materials used in all the cement plants of the Lehigh district of Pennsylvania and New Jersey, and also at a few western plants.

Type 2 includes cement made from a mixture of comparatively pure limestone with clay or shale. This mixture is employed at the majority of plants in the United States.

Type 3 includes cement manufactured from a mixture of marl and clay. This type of mixture is used in certain plants in the States of Michigan, Ohio, Indiana, New York, and Utah.

Type 4 includes Portland cement manufactured from a mixture of limestone and blast-furnace slag.

Production, in barrels, and percentage of total output of Portland cement in the United States according to type of material used, 1898–1911.

Year.	Type 1. Cement rock and pure limestone.		Type 2. Limestone and clay or shale.		Type 3. Marl and clay.		Type 4. Blast-furnace slag and limestone.	
	Quantity.	Percentage.	Quantity.	Percentage.	Quantity.	Percentage.	Quantity.	Percentage.
1898	2,764,694	74.9	365,408	9.9	562,092	15.2	....	....
1899	4,010,132	70.9	546,200	9.7	1,095,934	19.4	....	....
1900	5,960,739	70.3	1,034,041	12.2	1,454,797	17.1	32,443	0.
1901	8,503,500	66.9	2,042,209	16.1	2,001,200	15.7	164,316	1.
1902	10,953,178	63.6	3,738,303	21.7	2,220,453	12.9	318,710	1.
1903	12,493,694	55.9	6,333,403	28.3	3,052,946	13.7	462,930	2.
1904	15,173,391	57.2	7,526,323	28.4	3,332,873	12.6	473,294	1.
1905	18,454,902	52.4	11,172,389	31.7	3,884,178	11.0	1,735,343	4.
1906	23,896,951	51.4	16,532,212	35.6	3,958,201	8.5	2,076,000	4.
1907	25,859,095	53.0	17,190,697	35.2	3,606,598	7.4	2,129,000	4.
1908	20,678,693	40.6	23,047,707	45.0	2,811,212	5.5	4,535,300	8.
1909	24,274,047	37.3	32,219,365	49.6	2,711,219	4.2	5,786,800	8.
1910	26,520,911	34.6	39,720,320	51.9	3,307,220	4.3	7,001,500	9.
1911	26,812,129	34.1	40,665,332	51.8	3,314,176	4.2	7,737,000	9.

This table, which was last published in the report for 1908, shows continuation of movements whose trend has been noted in earlie years—the decrease in the relative production from cement rock (typ 1) and from marl (type 3), and the corresponding increase in the pro duction from limestone (type 2) and from slag (type 4). The fallin off in the relative output from marl was not unexpected, and th decrease in the percentage produced from cement rock is due simpl to the lessening comparative importance of the Lehigh district.

PRICES.

According to reports made to the United States Geological Surve by the manufacturers the average price by districts of Portlan cement per barrel in 1911 in bulk at the mills ranged between 71 cents in the Lehigh district and $1.406 on the Pacific coast, as con pared with 72.9 cents and $1.385 for the same districts in 1910. Th average price for the whole country was 84.4 cents in 1911, as con pared with 89.1 cents in 1910, a decrease of 4.7 cents a barre The lowest individual average price reported to the Survey was cents per barrel, and several mills sold as low as 65 to 67 cents, not only in the East but in the Middle West. The highest figure reported was $1.70 per barrel. The strongest reason for certain mills getting more than the average price for cement is advantageous location.

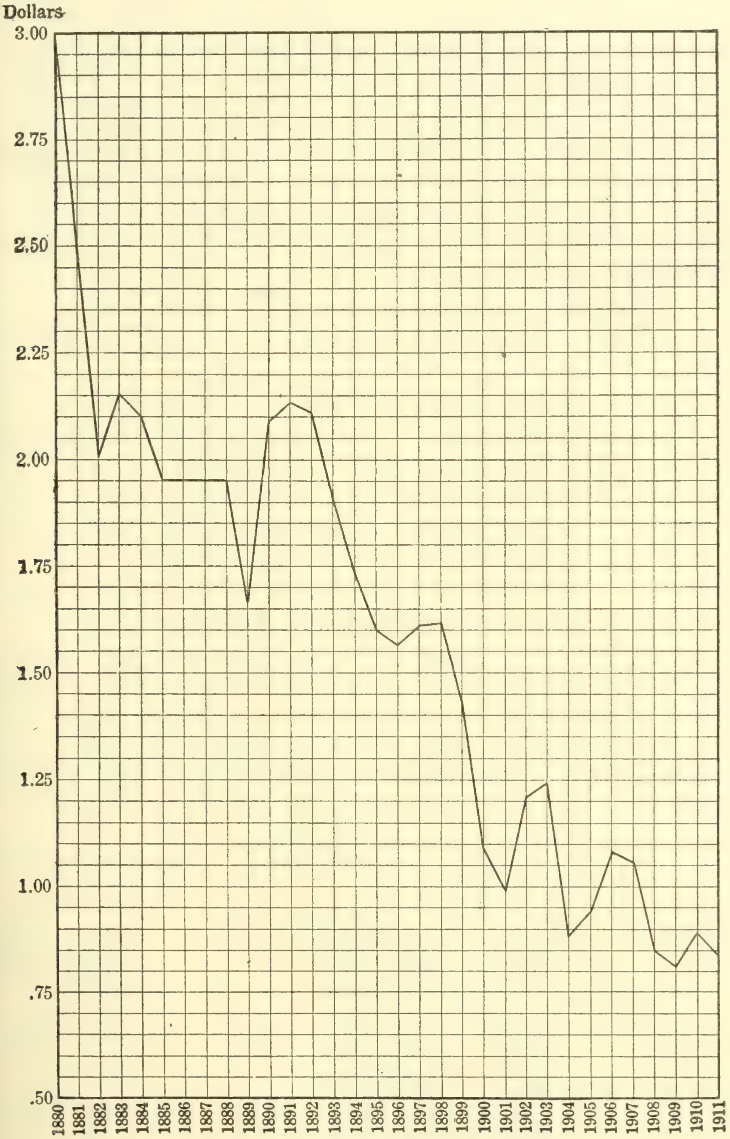

FIGURE 6.—Range in cement prices, 1880–1911.

Certain plants are situated close to large cities where they can sell a considerable portion of their output locally at better mill figures than can be obtained by plants which have to ship their product some distance, but there are only a few mills so favorably situated, and they are not the largest in the United States.

The year opened with prices on a downward grade. During the winter and early spring prices were at their lowest levels, reviving only when the building season was well under way and accumulated stocks showed signs of depletion. Late in the summer and in the early autumn prices had so far recovered that certain mills which had nearly or quite closed down during the first half of the year were enabled to resume operations and to sell some cement at prices that considerably exceeded the local average figures. On the other hand, however, many plants that operated more or less continuously the first part of the year found the demand so poor and the prices so low that they were forced to reduce their output or to close entirely during the autumn months. Taken as a whole and judged by the personal testimony of representative cement manufacturers from all States east of the Rocky Mountains, prices appear to have been very unsatisfactory.

The following table gives the average factory price of Portland cement per barrel in bulk from 1870 to 1911:

Average price per barrel of Portland cement, 1870–1911.

1870–1880	$3.00	1893	$1.91	1903	$1.24
1881	2.50	1894	1.73	1904	.88
1882	2.01	1895	1.60	1905	.94
1883	2.15	1896	1.57	1906	1.13
1884	2.10	1897	1.61	1907	1.11
1885–1888	1.95	1898	1.62	1908	.85
1889	1.67	1899	1.43	1909	.813
1890	2.09	1900	1.09	1910	.891
1891	2.13	1901	.99	1911	.844
1892	2.11	1902	1.21		

GROWTH OF THE PORTLAND CEMENT INDUSTRY, 1890-1911.

The growth of the industry for the years 1890 to 1911, inclusive, is illustrated graphically in figure 7. For comparison the decline in the natural cement industry is plotted on the same diagram.

In the following table statistics are given covering the annual production of Portland cement in the United States from the beginning of the industry in the early seventies to the present day:

Production of Portland cement in the United States, 1870–1911, in barrels.

Year.	Quantity.	Value.	Year.	Quantity.	Value.
1870–1879	82,000	$246,000	1899	5,652,266	$8,074,371
1880	42,000	126,000	1900	8,482,020	9,280,525
1881	60,000	150,000	1901	12,711,225	12,532,360
1882	85,000	191,250	1902	17,230,644	20,864,078
1883	90,000	193,500	1903	22,342,973	27,713,319
1884	100,000	210,000	1904	26,505,881	23,355,119
1885	150,000	292,500	1905	35,246,812	33,245,867
1886	150,000	292,500	1906	46,463,424	52,466,186
1887	250,000	487,500	1907	48,785,390	53,992,551
1888	250,000	487,500	1908	51,072,612	43,547,679
1889	300,000	500,000	1909	64,991,431	52,858,354
1890[a]	335,500	704,050	1910	76,549,951	68,205,800
1891	454,813	967,429	1911	78,528,637	66,248,817
1892	547,440	1,153,600	Total	507,752,834	495,225,971
1893	590,652	1,158,138			
1894	798,757	1,383,473			
1895	990,324	1,586,830			
1896	1,543,023	2,424,011			
1897	2,677,775	4,315,891			
1898	3,692,284	5,970,773			

[a] The figures for 1890 and previous years were estimates made at the close of each year and are believe to be substantially correct. Since 1890 the official figures are based on complete returns from all producers

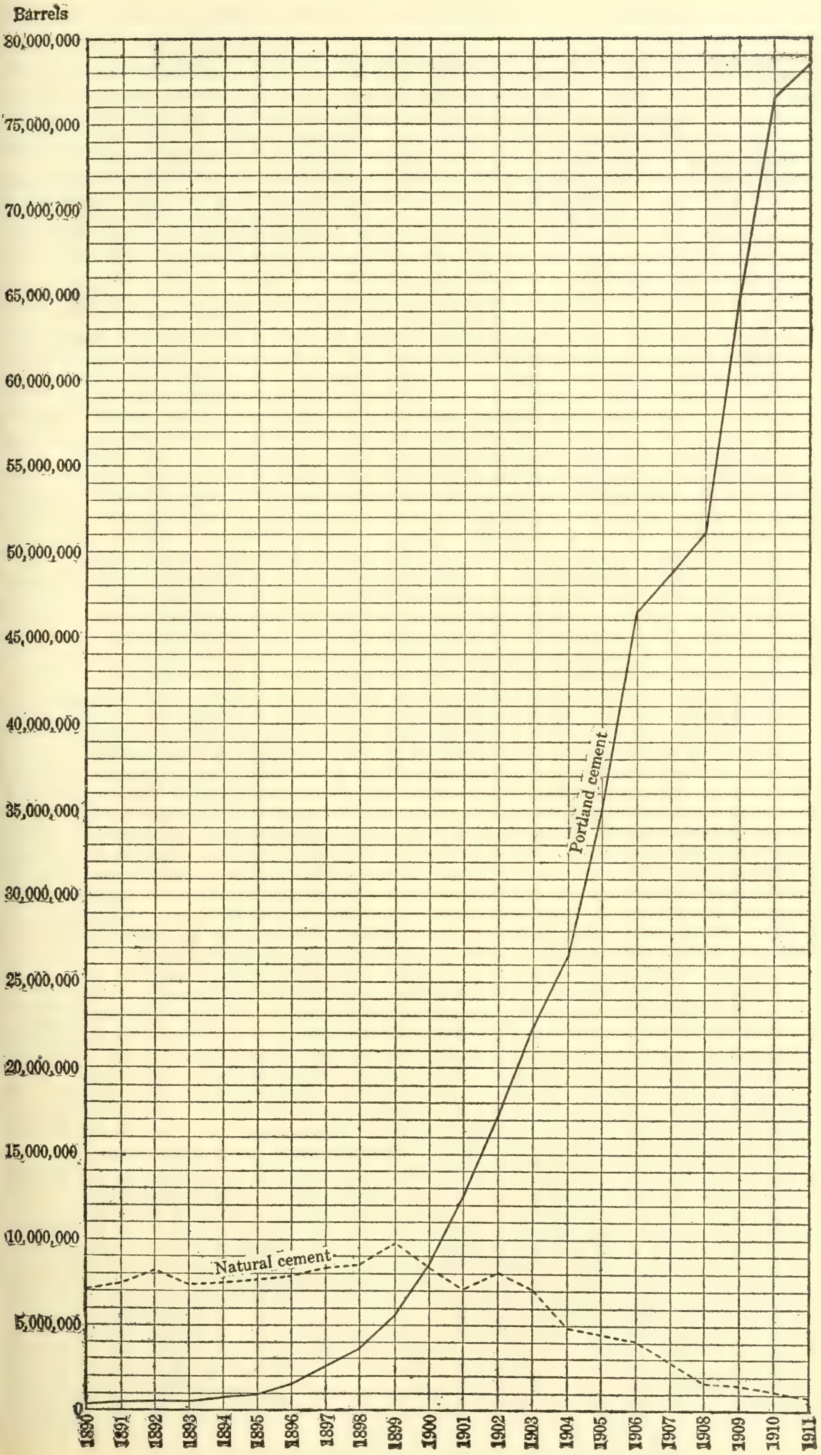

FIGURE 7.—Production of Portland and natural cements, 1890-1911.

On examination of this table and curve it will be seen that the industry showed a fair but not in any way remarkable rate of growth from its beginning in the seventies until 1895. At the latter date, however, a very striking development commenced, coincident, it may be noted, with the development of coal burning in the rotary kiln. This rapid rate of growth continued until 1907, when it was checked temporarily by the financial crisis of that year. Still later there was another short era of growth more rapid than ever before, only to be checked in 1911 by a combination of factors the most important of which were overproduction in 1910 and generally quiet business conditions in 1911.

On examining the cement statistics for the series of years, it will be seen that the output of Portland cement has so far shown an increase each year, rising from 42,000 barrels in 1880 to 335,500 barrels in 1890, to 8,482,020 barrels in 1900, and to 78,528,637 barrels in 1911. The natural-cement production, on the other hand, reached its maximum in 1899, with an output of 9,868,179 barrels. Since that year it has shown an almost continuous decrease annually, until now it has become a relatively unimportant factor in the cement market.

CONDITION OF THE PORTLAND CEMENT INDUSTRY.

The Cement Age, a magazine which is in particularly close touch with the cement manufacturing industry in the eastern United States, says in its issue of December, 1911:

> The situation presents a peculiar paradox. Here is a great industry showing constant development and increase in production, but the situation from the standpoint of the manufacturer is far from encouraging, owing to extremely low prices. There are no dividends in sight, and some of the mills are in the sheriff's hands. The manufacturer is, perhaps, willing to wager odds that no increase will be shown next year. But from the standpoint of the publisher again, which should be the broadest possible premise, we can extend sympathy to the manufacturer and at the same time congratulate the country at large upon having a great and stable industry that has developed within a decade, so to speak. Cement must be used, and, for some time to come, in increasing quantities. If manufacturers generally reduce their output because of low prices, a falling off in 1911 figures will not represent a decline in the use of cement. It seems to us that this is an important distinction to make. There is a vast difference between curtailment of production because of cessation of demand, and curtailment made necessary by price cutting that has necessitated sales at less than the cost of production. The former is always a serious blight, the latter a condition that can be remedied. There are only two things that can check the demand for cement. One would be the discovery of a better and cheaper material, and [the other] the cessation of all structural work. Neither is likely to happen. Thus it is as certain as anything can be that the cement industry is destined to endure and expand. We specified a year ago the important agencies at work in the interest of cement and described the educational methods adopted to promote its use. There has been no retrogression in this field. As a consequence cement has been substituted for wood, brick, and stone in countless structural undertakings. Every example of good concrete work becomes the center of an ever-widening circle of like construction. Thus the great industry as a national asset, so to speak, represents something encouraging in every sense. The situation confronting manufacturers as individuals or as a body is something different, a problem they must solve. In justice to the manufacturer it should be said that his is not the easy proposition of transforming by simple and inexpensive methods a cheap raw material into a product representing big profits. On the contrary, the making of a sound and uniform cement is a highly scientific problem involving the most accurate mechanical processes as well as exact chemical analyses, and it may be said without fear of contradiction that the present price of cement is ridiculously inadequate compensation for the capital and scientific knowledge expended in its production. The manufacturer, however, is attempting to accomplish even more in this direction by making closer calculations as to cost of

production, but the industry has reached the point where further progress in this direction seems impossible. A saving of a few cents a barrel in the cost of manufacture, or a few cents added to the selling price, has become a matter of great moment to the manufacturer, but to the consumer an increase of 10 cents a barrel, which would have represented in 1910 some seven or eight millions saved to the hundred or more companies, would, for example, add but $10 or $15 extra cost in the building of a $3,000 concrete house. Considering this side of the industry the cement manufacturer has been a veritable anomaly in modern commercial and industrial development. His industry enjoys the unique distinction of being the only one of its magnitude that has been practically free from overcapitalization. The price of his product is so low that one could not scrape the free sand from the gutters at much less cost per barrel than the present price of cement. However that may be, and whatever the manufacturer may elect to do in the future, it will develop upon somebody to make the cement this country needs, and it is very certain that a vast deal more will be required than is being made at the present time.

There is little to add to this clear-cut editorial except to say that the Survey statistics, in so far as they are applicable, seem to bear the same testimony, with the qualification that in years such as the one just past, when general business conditions are not quite up to their normal tone, construction work is one of the first lines to feel the reaction and to result in a less vigorous demand for cement. It is worthy of note, however, that while many of the staple mineral products of the United States (pig iron, for instance) showed a decided decrease in output in 1911, the annual production of Portland cement has yet to show a decrease.

MANUFACTURING CONDITIONS.

In 1911 there were 115 plants reported as having produced Portland cement, as compared with 111 plants in 1910. The total number of rotary kilns in the producing plants was 916 as compared with 900 in 1910. These kilns ranged in length from 40 to 240 feet, and the lengths as reported were distributed as follows:

Lengths of rotary cement kilns in the United States, 1910 and 1911.

Length.	1910	1911	Length.	1910	1911
	Number of kilns.	Number of kilns.		Number of kilns.	Number of kilns.
Feet.			*Feet.*		
40 to 60	236	208	125	153	163
60 to 90	182	149	125 to 140	18	60
100	77	84	150 or more	22	26
110	138	140			
120	74	86	Total	900	916

It is of interest to note that the gains were all in kilns 100 feet or more in length and that these gains more than balanced numerically the smaller kilns which were shut down, giving a total of 559 kilns 100 feet or more in length in 1911 as against 473 kilns in 1910. The 125-foot kiln is apparently still the most common length for modern kilns. From the reports received it is apparent that the total annual kiln capacity of the country in 1911, allowing for reasonable loss of time for repairs, should have been about 112,500,000 barrels, and that the total production 78,528,637 barrels represented about 70 per cent of the total capacity. As compared with the estimated total kiln capacity in 1910, which was 97,670,000 barrels of Portland cement, the capacity in 1911 increased 14,830,000 barrels, or far in excess of the actual increase in production. The apparent average output per kiln in 1911 was about 85,730 barrels, as compared with 85,000 barrels in 1910. This increase is easily explained by the greater average size of the kilns operated during 1911. According to the mill reports all but about 30 of the producing plants in the United States were shut down part of the time for causes other than repairs for periods ranging from 2 to 10 months. Shutdowns for repairs ranged from 2 to 6 weeks. The following 9 new plants reported their first commercial output in 1911: Golden State Portland Cement Co., Oro Grande, Cal.; Piedmont Portland Cement Co., Portland, Ga.; Lehigh Portland Cement Co., Mason City, Iowa; Chanute Cement Co., Chanute, Kans.; Tidewater Portland Cement Co., Union Bridge, Md.; Michigan Portland Cement Co., Chelsea, Mich.; Knickerbocker Portland Cement Co., Hudson, N. Y.; Clinchfield Portland Cement Corporation, Kingsport, Tenn.; and Inland Portland Cement Co., Metaline Falls, Wash. In addition, 1 plant in the Lehigh district which was idle in 1910 reported a production in 1911. Against these there were 6 plants idle in 1911 that produced cement in 1910, distributed as follows: One each in Arizona and Pennsylvania, 2 in Michigan, and 2 in New York.

A summary of the kiln fuels used shows that 87 plants burned pulverized coal, 19 burned oil, and 9 burned natural gas. In a few plants oil was used in conjunction with coal and natural gas, and in one plant natural gas was used in connection with coal. Producer gas has also been reported as used in 1 plant in former years.

IMPORTS OF FOREIGN CEMENT.[1]

The following table shows the quantities of foreign cement imported for consumption into the United States during the years 1878 to 1911, inclusive. It is to be noted that, owing to the manner in which import statistics are grouped under existing tariff schedules, the quantities given include not only Portland cement but all other hydraulic cements. The Portland cement, however, probably makes up at least 95 per cent of the total in each year.

The table shows a continuous decline in the imports of foreign cement for the last five years. In 1906 and 1907 the imports increased tremendously over those of 1905, principally on account of the rebuilding of San Francisco following the fire.

Imports of foreign cement, 1878–1911, in barrels.[2]

1878	92,000	1890	1,940,186	1901	939,330
1879	106,000	1891	2,988,313	1902	1,963,023
1880	187,000	1892	2,440,654	1903	2,251,969
1881	221,000	1893	2,674,149	1904	968,409
1882	370,406	1894	2,638,107	1905	896,845
1883	456,418	1895	2,997,395	1906	2,273,493
1884	585,768	1896	2,989,597	1907	2,033,438
1885	554,396	1897	2,090,924	1908	842,121
1886	915,255	1898	1,152,861	1909	443,888
1887	1,514,095	1899	2,108,388	1910	306,863
1888	1,835,504	1900	2,386,683	1911	164,670
1889	1,740,356				

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[1] Data according to the Bureau of Statistics, Department of Commerce and Labor.

[2] The statistics from 1899 to the present represent "Imports for consumption." The figures for all preceding years are for "Total imports."

EXPORTS.

The United States has a comparatively small export trade in cement. In 1911 the total quantity exported was only 3,135,409 barrels, most of which was Portland cement, valued at $4,632,215, or approximately $1.477 per barrel. This quantity was slightly less than 4 per cent of the total production in 1911. There seem to be excellent reasons for increasing this export trade as rapidly as possible. The exports in 1910 increased nearly 135 per cent over those of 1909, but those in 1911 increased only 26.6 per cent over those of 1910. Recently published data [1] indicate that American manufacturers are not yet making the most of their opportunities to establish a profitable export trade. Comparative figures show that in 1910 England exported about 4,400,000 barrels, Germany about 4,250,000 barrels, Belgium about 4,200,000 barrels, and France about 1,900,000 barrels, and that these quantities are, with one exception, not only considerably greater than the exports of the United States but that all of them bear a much higher ratio to the production in these respective countries than does that of the United States. The quantity exported by France is estimated at fully 23 per cent of her total production; the total production of Germany is stated to be between 25,000,000 and 26,000,000 barrels; so that if the United States were exporting in the same ratio to her production as does Germany the foreign sales should have reached more than 13,000,000 barrels in 1911. Dr. Schott has made a number of suggestions based on observations of German and other foreign conditions and methods which are worthy of prompt and serious consideration by American manufacturers.

The following table gives the quantity and value of all classes of hydraulic cement exported during the years 1900–1911, inclusive. These totals represent almost entirely exports of Portland cement.

Exports of hydraulic cement, 1900–1911, in barrels.

Year.	Quantity.	Value.	Year.	Quantity.	Value.
1900	100,400	$225,306	1906	583,299	$944,886
1901	373,934	679,296	1907	900,550	1,450,841
1902	340,821	526,471	1908	846,528	1,249,229
1903	285,403	433,984	1909	1,056,922	1,417,534
1904	774,940	1,104,086	1910	2,475,957	3,477,981
1905	897,686	1,387,906	1911	3,135,409	4,632,215

PORTLAND CEMENT CONSUMPTION IN GOVERNMENT WORK.

Inquiries have frequently reached the Survey with regard to the total annual consumption of Portland cement by public works that are under Federal supervision. Large quantities of cement are used each year in the construction of Federal buildings under the charge of the Supervising Architect of the Treasury Department. These buildings are built by contract, and the cement that enters into their construction is furnished under the general contracts, so that the Office of the Supervising Architect has no data as to the quantity thus consumed.

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[1] Schott, Otto, Vital question of cement industry: Rock products, December, 1911, p. 50, and February, 1912, p. 55. See also Export markets for American cement: Cement Age, February, 1912, pp. 93–95.

The construction work of the Isthmian Canal required shipments from the United States of 1,680,140 barrels of Portland cement in 1911 and of 1,572,568 barrels in 1910. The cost of this cement to the Canal Commission averaged approximately 93 cents per barrel delivered at Jersey City, N. J.[1]

The United States Reclamation Service used in 1911 in its construction work 135,481 barrels of Portland cement averaging in cost $1.32 per barrel at the mills, as compared with 119,083 barrels averaging $1.06 at the mills in 1910. The apparently increased cost of cement for 1911 over that for 1910 was chiefly owing to the fact that in 1911 a larger quantity was purchased from the western mills at higher figures at the mill but at lower cost to the Service for the cement delivered at the projects where the cement was used.[2]

PORTLAND CEMENT IN CANADA.

According to the preliminary report on the mineral production of Canada during the calendar year 1911, issued by the Canada department of mines, mines branch, February 27, 1912, the total quantity of Portland cement manufactured in Canada in 1911 was 5,677,539 barrels, as compared with 4,396,282 barrels in 1910, an increase of 1,281,257 barrels, or 29 per cent. The total quantity of Portland cement sold during the year was 5,635,950 barrels as compared with 4,753,975 barrels sold in 1910, an increase of 881,975 barrels, or 18.6 per cent. The average price per barrel at the mills in both 1911 and 1910 was $1.34.

The imports of Portland cement into Canada in 1911 were 661,91 barrels of 350 pounds at an average price of $1.26 per barrel; the imports in 1910 were 349,310 barrels at an average price of $1.34 The imports in 1911 constituted about 10.5 per cent of the total consumption, as compared with 7 per cent in 1910.

PORTLAND CEMENT IN CUBA.

There is one Portland cement plant in Cuba, the Almendares located in the western outskirts of Habana. Its present maximu capacity is reported as approximately 288,000 barrels of "Volcan Portland cement. The present total annual consumption of Portland cement in Cuba is approximately 648,000 barrels, of whic 360,000 barrels are imported. Of these imports the United State supplies about 74 per cent; Belgium, 14 per cent; France, 8 per cen Germany and other countries, 4 per cent. The imports from Franc are largely of white cement.

The import duty on cement into Cuba is reported to be 30 cents p 100 kilograms from the United States, and 37.5 cents per 100 kil grams from all other countries.

PORTLAND CEMENT IN THE PHILIPPINES.

No Portland cement is at present made in the Philippine Island Investigations are under way by at least two concerns which propo to erect mills if the raw materials, fuel, and manufacturing and tran portation conditions are found to be sufficiently favorable. In vie of the limited market it would appear probable that the first plant that is built will practically control the situation. The total imports of all kinds of cement (principally Portland) into the Philippine Islands in 1911 was 402,933 barrels of 380 pounds, valued at $630,401, as compared with 351,498 barrels, valued at $600,758, in 1910. The average price per barrel in 1911 was $1.565 as compared with $1.709 in 1910.

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[1] Communication from Isthmian Canal Commission. [2] Communication from Reclamation Service

The following table shows the imports of cement into the Philippine Islands in 1910 and 1911 by countries:[1]

Imports of cement into the Philippine Islands by principal countries during the calendar years 1910 and 1911 ending Dec. 31.[a]

Country.	1910		Per cent of total quantity.	1911		Per cent of total quantity.
	Quantity.	Value.		Quantity.	Value.	
	Pounds.			*Pounds.*		
United States	33,243,912	$174,939	24.9	2,371,325	$20,917	1.5
Germany	8,385,110	40,001	6.3	15,166,453	60,004	9.9
Hongkong	61,452,987	256,694	46.0	102,052,482	402,914	66.7
French East Indies	25,939,154	110,664	19.4	29,975,739	131,117	19.6
Other countries	4,548,036	18,460	3.4	3,548,489	15,449	2.3
Total import	133,569,199	600.758	100.0	153,114,488	630,401	100.0
Barrels	351,498			402,933		
Price per barrel		$1.709			$1.565	

[a] Including imports on account of Government and railway free entries.

TECHNOLOGIC NOTES.

DEFINITION OF PORTLAND CEMENT.

Portland cement is the product obtained by calcining to a clinker a finely ground artificial mixture of properly proportioned calcareous and argillaceous substances and finely grinding the resulting clinker. Only such additions are permitted subsequent to the calcining as may be necessary to control certain properties, and such additions should not exceed 3 per cent by weight of the calcined product.

RAW MATERIALS.

The raw materials consist essentially of lime, silica, alumina, and iron oxide in certain definite proportions, obtained by mixing limestone or marl with clay or shale, or by substituting low-magnesia blast-furnace slag for clay or shale. The clay, shale, or slag furnish silica, alumina, and iron oxide. Impure limestone, called "cement rock," in which all the ingredients are present in nearly the proper proportions, is also used alone or is corrected by the addition of purer limestone. The mixture of raw materials should contain about three parts of lime carbonate to one part of the clayey materials. The calcination or burning takes place at a high temperature, approaching 3,000° F., and must therefore be carried on in kilns of special design and lining. During the burning chemical combination of the lime, silica, alumina, and iron oxide takes place. The product of the burning is a semifused mass called "clinker," which consists of silicates, aluminates, and ferrites of lime in certain fairly definite proportions. This clinker must be finely ground. A small and limited percentage of gypsum (hydrous calcium sulphate) is ground with the clinker. After such grinding the powder (Portland cement) will set under water.

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[1] Communication from Bureau of Insular Affairs.

OUTLINE OF MANUFACTURE.

There are two methods of manufacture, the dry and the wet process, differing from each other in certain details of mixing. In a modern plant using the dry process, the limestone and the clay or shale are brought to the mill in tramcars, are coarsely crushed, dried if necessary in rotary cylindrical driers, and are stored in silos. The raw materials are next charged in certain definite proportions by weight, as indicated by their chemical composition, into fine grinding mills which intimately mix the materials during grinding. This fine grinding is performed in various types of mills, such as steel ball, silica pebble tube mills, and mechanical mills. The product leaves these mills so finely ground that more than half of it will usually pass a screen having 200 meshes to the linear inch. The fine mixtures are then stored to supply the kilns. The modern kiln is of the rotary cylinder type. It consists of a cylindrical steel shell lined with highly refractory material. Recently built kilns range from 110 to 240 feet in length and from 7 to 12 feet in diameter. The axis of the kiln is slightly inclined from the horizontal; the upper end enters into the chimney hood and the lower end receives the fuel nozzles. The fine raw mixture is fed mechanically into the upper end of the rotary kiln, where it travels slowly through the kiln and is acted upon by the incandescent gases which are forced in the opposite direction. Pulverized coal in an air blast is the fuel most widely used for burning cement, but crude oil and natural gas are also used in localities where they are plentiful, and producer gas has been used in a small way. Under the influence of heat the ingredients in the fine particles are fused together into small, hard lumps called "clinker." The hot clinker falls in a stream from the lower end of the kiln into a steel bucket conveyor and is carried into the air and cooled, then dumped into heaps and allowed to age or become "seasoned." To this clinker after seasoning is added a small percentage of gypsum, after which the whole mass is crushed and ground to such fineness that 90 to 95 per cent shall pass a sieve having 100 meshes to the linear inch and 75 to 80 per cent a sieve having 200 meshes to the linear inch. The fine grinding is performed by mills similar to those used for grinding finely the raw materials. It is then conveyed mechanically to the stock house for storage prior to shipment. Most cement is sold in bags weighing 95 pounds each (4 sacks of 380 pounds of cement constituting a barrel). There are devices for automatically filling and weighing sacks so that a large output can be rapidly handled. If blast-furnace slag is used instead of clay or shale, the process is essentially the same as that already outlined. Instead of deriving the slag from quarries in solid slag heaps, fresh molten slag direct from the blast furnace is granulated b suddenly cooling it with a stream of water, and the granulated slag i then dried and subject to a preliminary grinding, after which it i mixed in automatic weighing machines with the proper proportion o high-calcium limestone.

The wet or slurry process is employed where wet marl is dredged rom the bottoms of lakes, and it is also employed by several plants using hard limestone and clay or shale. In this process the materials are ground in water and are pumped through pipes to slurry tanks where they are thoroughly stirred. From 32 to 40 per cent of water is carried by the slurry, which is next pumped to the kilns. The drying is accomplished in the upper part of the kiln, and the clinkering and inishing of the cement proceeds as in the dry process.

SPECIFICATIONS.

Since June, 1911, a committee composed of Government engineers n conference with representative consumers and manufacturers and special committees of the national engineering societies, has been engaged in formulating a single specification for Portland cement to be used by all departments of the Government. This committee has had in view the desirability of an agreement between the specifications in use by the public and those adopted by the Government. At a departmental conference held February 13, 1912, a set of liberal specifications was unanimously adopted, and simultaneously with their publication the following Executive order was issued:

EXECUTIVE ORDER.

It is hereby ordered that all Portland cement that may hereafter be purchased by any department, bureau, office, or independent establishment of the Government, or that may be used in construction work connected with any of the aforesaid branches of the Government service, shall conform in every respect to the specification for Portland cement adopted by the departmental conference at the meeting held at the Bureau of Standards on February 13, 1912, and approved by the heads of the several departments (to be known as the United States Government specification for Portland cement): Provided, however, that such specification may be modified from time to time by any similar departmental conference, with the approval of the heads of the several departments.

Wm. H. Taft.

The White House,
April 30, 1912.

UNITED STATES GOVERNMENT SPECIFICATION FOR PORTLAND CEMENT.[1]

SPECIFICATION.

Definition.—1. The cement shall be the product obtained by finely pulverizing clinker produced by calcining to incipient fusion an intimate mixture of properly proportioned argillaceous and calcareous substances, with only such additions subsequent to calcining as may be necessary to control certain properties. Such additions shall not exceed 3 per cent, by weight, of the calcined product.

Composition.—2. In the finished cement the following limits shall not be exceeded:

	Per cent.
Loss on ignition for 15 minutes	4
Insoluble residue	1
Sulphuric anhydride (SO_3)	1.75
Magnesia (MgO)	4

Specific gravity.—3. The specific gravity of the cement shall not be less than 3.10. Should the cement as received fall below this requirement, a second test may be made upon a sample heated for 30 minutes at a very dull red heat.

Fineness.—4. Ninety-two per cent of the cement, by weight, shall pass through the No. 100 sieve, and 75 per cent shall pass through the No. 200 sieve.

Soundness.—5. Pats of neat cement prepared and treated as hereinafter prescribed shall remain firm and hard and show no sign of distortion, checking, cracking, or disintegrating. If the cement fails to meet the prescribed steaming test, the cement may be rejected or the steaming test repeated after seven or more days, at the option of the engineer.

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[1] United States Government specification for Portland Cement: Cir. Bur. Standards No. 33, U. S. Dept. Com. and Labor, May 1, 1912.

Time of setting.—6. The cement shall not acquire its initial set in less than 45 minutes and must have acquired its final set within 10 hours.

Tensile strength.—7. Briquets made of neat cement, after being kept in moist air for 24 hours and the rest of the time in water, shall develop tensile strength per square inch as follows:

	Pounds.
After 7 days	500
After 28 days	600

8. Briquets made up of 1 part cement and 3 parts standard Ottawa sand, by weight, shall develop tensile strength per square inch as follows:

	Pounds.
After 7 days	200
After 28 days	275

9. The average of the tensile strengths developed at each age by the briquets in any set made from one sample is to be considered the strength of the sample at that age, excluding any results that are manifestly faulty.

10. The average strength of the sand-mortar briquets at 28 days shall show an increase over the average strength at 7 days.

Brand.—11. Bids for furnishing cement or for doing work in which cement is to be used shall state the brand of cement proposed to be furnished and the mill at which made. The right is reserved to reject any cement which has not established itself as a high-grade Portland cement and has not been made by the same mill for two years and given satisfaction in use for at least one year under climatic and other conditions at least equal in severity to those of the work proposed.

Packages.—12. The cement shall be delivered in sacks, barrels, or other suitable packages (to be specified by the engineer), and shall be dry and free from lumps. Each package shall be plainly labeled with the name of the brand and of the manufacturer.

13. A sack of cement shall contain 94 pounds net. A barrel shall contain 376 pounds net. Any package that is short weight or broken or that contains damaged cement may be rejected, or accepted as a fractional package, at the option of the engineer.

Inspection.—14. The cement shall be tested in accordance with the standard methods hereinafter prescribed. In general the cement will be inspected and tested after delivery, but partial or complete inspection at the mill may be called for in the specifications or contract. Tests may be made to determine the chemical composition, specific gravity, fineness, soundness, time of setting, and tensile strength, and a cement may be rejected in case it fails to meet any of the specified requirements. An agent of the contractor may be present at the making of the tests or they may be repeated in his presence.

15. In case of failure of any of the tests, and if the contractor so desires, the engineer may, if he deem it to the interest of the United States, have any or all of the tests made or repeated by the Bureau of Standards, United States Department of Commerce and Labor, in the manner hereinafter specified, all expenses of such tests to be paid by the contractor. All such tests shall be made on samples furnished by the engineer.

After these articles of specification the subject is continued in detail in the Bureau of Standards circular under the heads, "Standard methods of testing," "Methods of chemical analysis," "Interpretation of results," and "Auxiliary specifications," the last being mainly Bureau of Standards specifications for certain apparatus to be used in making tests. Under "Interpretation of results" a number of points are discussed that are of great importance in connection with the specifications quoted above.

INTERPRETATION OF RESULTS.[1]

CHEMICAL.

The composition of normal Portland cement has been the subject of a great deal of investigation, and it can be said that the quantities of silica, alumina, oxide of iron, lime, magnesia, and sulphuric anhydride can vary within fairly wide limits without materially affecting the quality of the material.

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[1] Circ. Bur. Standards No. 33, U. S. Dept. Commerce and Labor, May 1, 1912.

A normal American Portland cement which meets the standard specifications for soundness, setting time, and tensile strength has an approximate composition within the following limits:

	Per cent.
Silica (SiO_2)	19–25
Alumina (Al_2O_3)	5–9
Iron oxide (Fe_2O_3)	2–4
Lime (CaO)	60–64
Magnesia (MgO)	1–4
Sulphur trioxide (SO_3)	1–1. 75
Loss on ignition	0. 5–3. 00
Insoluble residue	0. 1–1. 00

It is also true that a number of cements have been made both here and abroad which have passed all standard physical tests in which these limits have been exceeded in one or more particulars, and it is equally true that a sound and satisfactory cement does not necessarily result from the above composition.

It is probable that further investigation will give a clearer understanding of the constitution of Portland cement, but at present chemical analysis furnishes but little indication of the quality of the material.

Defective cement usually results from imperfect manufacture, not from faulty composition. Cement made from very finely ground material, thoroughly mixed and properly burned, may be perfectly sound when containing more than the usual quantity of lime, while a cement low in lime may be entirely unsound due to careless manufacture.

The analysis of a cement will show the uniformity in composition of the product from individual mills, but will furnish little or no indication of the quality of the material. Occasional analysis should, however, be made for record and to determine the quantity of sulphuric anhydride and magnesia present.

The ground clinker as it comes from the mill is usually quick setting which requires correction. This is usually accomplished by the addition of a small quantity of more or less hydrated calcium sulphate, either gypsum or plaster of Paris. Experience and practice have shown that an addition of 3 per cent or less is sufficient for the purpose.

Three per cent of calcium sulphate ($CaSO_4$) contains about 1.75 per cent sulphuric anhydride (SO_3), and as this has been considered the maximum quantity necessary to control time of set, the specification limits the SO_3 content to 1.75 per cent.

The specification prohibits the addition of any material subsequent to calcination except the 3 per cent of calcium sulphate permitted to regulate time of set. Other additions may be difficult or impossible to detect even by a careful mill inspection during the process of manufacture, but as the normal adulterant would be ground raw material, an excess of "insoluble residue" would reveal the addition of siliceous material, and an excess in "loss on ignition" would point to the addition of calcareous material when either is added in sufficient quantity to make the adulteration profitable.

The effect of relatively small quantities of magnesia (MgO) in normal Portland cement, while still under investigation, can be considered harmless. Earlier investigators believed that as magnesia had a slower rate of hydration than lime, the hydration of any free magnesia (MgO) present would occur after the cement had set and cause disintegration.

The effect of magnesia was considered especially injurious when the cement was exposed to the action of sea water. More recent investigation has shown that cement can be made which is perfectly sound under all conditions when containing 5 per cent of magnesia and it has also been found that the lime in Portland cement exposed to sea water is replaced by magnesia.

The maximum limit for magnesia has been set at 4 per cent, as it has been established that this quantity is not injurious and it is high enough to permit the use of large quantities of raw material available in most sections of the country.

PHYSICAL.

Specific gravity.—The specific gravity is obtained from the formula:

$$\text{Specific gravity} = \frac{\text{Weight of cement in grams.}}{\text{Displaced volume in cubic centimeters.}}$$

The specific gravity of a Portland cement is not an indication of its cementing value. It will vary with the constituents of the cement, especially with the content of iron oxide. Thus the white or very light Portland cements, containing only a fraction of a per cent of iron oxide, usually have a comparatively low specific gravity ranging from 3.05 to 3.15, while a cement containing 3 to 4 per cent or more of iron oxide may have a specific gravity of 3.20 or even higher. It is materially affected by the temperature and duration of burning the cement, the hard-burned cement having the higher specific gravity. A comparatively low specific gravity does not necessarily indicate that a cement is underburned or adulterated, as large percentages of raw materials could be added to a cement with a normally high specific gravity before the gravity would be reduced below 3.10.

If a Portland cement fresh from the mill normally has a comparatively low specific gravity, upon aging it may absorb sufficient moisture and carbon dioxide to reduce the gravity below 3.10. It has been found that this does not appreciably affect the cementing value of the material; in fact, many cements are unsound until they have been aged. Thus a redetermination is permitted upon a sample heated to a temperature sufficient to drive off any moisture which might be absorbed by the cement subsequent to manufacturing, but would not drive off any carbon dioxide nor correct underburning in the process of manufacturing the cement.

The value of the specific gravity determination lies in the fact that it is easily made in the field or laboratory, and when the normal specific gravity of the cement is known, any considerable variation in quality due to underburning or the addition of foreign materials may be detected.

Fineness.—Only the extremely fine powder of cement called flour possesses appreciable cementing qualities and the coarser particles are practically inert. No sieve is fine enough to determine the flour in a cement, nor is there any other means of accurately and practically measuring the flour. Some cements grind easier than others; thus, although a larger percentage of one cement may pass the 200-mesh sieve than another, the former may have a smaller percentage of actual flour due to the difference in the hardness and the character of the clinker and the method used in grinding. Thus the cementing value of different cements can not be compared directly upon their apparent fineness through a 200-mesh sieve. With cement from the same mill, with similar clinker and grinding machinery, however, it is probable that the greater the percentage which passes the 200-mesh sieve the greater the percentage of flour in that particular cement.

Normal consistency.—The quantity of water used in making the paste from which the pats for soundness, tests of setting, and the briquets are made is very important and may vitally affect the results obtained. The determination consists in measuring the quantity of water required to bring a cement to a certain state of plasticity.

In determining the normal consistency by the ball method, after mixing the paste it should be formed into a ball with as little working as possible and a new batch of cement should be mixed for each trial paste. In order to obtain just the requisite quantity of paste to form a ball 2 inches in diameter, a measure made from a pipe with a 2-inch inside diameter cut 1½ inches long would be found convenient. The section of pipe should be open at both ends, so that it can be pushed down into the paste on the mixing table and the excess paste cut off with a trowel. The appearance of the ball, using the correct percentage of water for normal consistency as compared with a less and greater quantity of water, is [illustrated in the Bureau of Standards circular].

Mixing.—The homogeneity of the cement paste is dependent upon the thoroughness of the mixing, and this may have considerable influence upon the time of setting and the strength of the briquets.

Soundness.—The purpose of this test is to detect those qualities in a cement which tend to destroy the strength and durability. Unsoundness is usually manifested by a change in volume, which causes cracking, swelling, or disintegration. If the pat is not properly made, or if it is placed where it will be subject to any drying during the first 24 hours, it may develop what are known as shrinkage cracks, which are not an indication of unsoundness and should not be confused with disintegration cracks. * * * No shrinkage cracks should develop after the first 24 or 28 hours. The failure of the pats to remain on the glass nor the cracking of the glass to which the pat is attached does not necessarily indicate unsoundness. In molding the pats the cement paste should first be flattened on the glass and the pat formed by drawing the trowel from the outer edge toward the center. * * *

Time of setting.—The purpose of this test is to determine the time which elapses from the moment water is added until the paste ceases to be plastic and the time required for it to obtain a certain degree of hardness. The determination of the "initial set," or when plasticity ceases, is the more important, as a disturbance of the material after this time may cause a loss of strength, and thus it is important that the mixing and molding or the incorporating of the material into the work be accomplished within this time. The time of setting is usually determined upon one of the pats which is to be used for the soundness test, the top surface being flattened somewhat. * * * In using the Gillmore needles care should be taken to apply the needles in a vertical position and perpendicular to the surface of the pat. An arrangement [has been perfected] for mounting the Gillmore needles so that they are always perpendicular to the surface of the pat. The rate of setting and hardening may be materially affected by slight changes in temperature. The percentage of water used in gaging and the humidity of the moist closet in which the test pieces are stored may also affect the setting somewhat.

Tensile tests.—Consistent results can only be obtained by exercising great care in molding and testing the briquets. The correct method of filling the mold [is illustrated in the circular]. In testing, the sides of the briquet and the clips should be thoroughly cleaned and free from grains of sand or dirt, which would prevent a good bearing, and the briquet should be carefully centered in the clips so as to avoid cross strains. It may be considered good laboratory practice if the individual briquets of any set do not show a greater variation from the mean value than 8 per cent for sand mixtures and 12 per cent for neat mixtures.

WATERPROOFING CONCRETE.

To render cement mortar and concrete water-tight has long been one of the hopes of cement users. In response to the supposed necessity for the addition of some foreign material that might act as a waterproofing or damp-proofing agent, fifty or more substances have been put on the market and sold under strong claims as to their efficiency. In response to the demand for light on this subject, a series of tests were carried on at the structural-materials laboratories of the United States Geological Survey in St. Louis, Mo. When this work was transferred to the Bureau of Standards on July 1, 1910, the unpublished data were delivered to that bureau, and only recently have they been made public.[1]

In arranging these tests it was necessary to determine the permeability and absorption of Portland cement mortars and concretes made with typical materials, and to ascertain the necessity for and the value of so-called waterproofing and damp-proofing mediums, as well as to determine the composition of the compounds and materials recommended for such uses.

The permeability tests of mortars and concretes were applied to mortar and concrete made with several different proportions by volume of Portland cement and different grades of sand, also with various proportions of several grades of sand and stone. The consistency was either damp or quaking, and the thickness of the test pieces was varied. The tests extended from three to six weeks and were made in triplicate. Some of the important points with regard to the character of mortar and concrete that were demonstrated are as follows:

In the permeability tests of mortar the richer the mixture in cement the less permeable was the mortar. The quaking-consistency was less permeable than the damp-consistency. The quantity of water passing through decreases with the continuation of the flow. The permeability was approximately the same for similar mortars, whether in a 1-inch, 2-inch, or 3-inch thickness of test piece. The permeability of the mortar decreases with its age. The coarse sand mortar was more permeable than the fine-grained sand mortar. The value of troweling mortar surfaces was also demonstrated by the tests.

In the case of the concretes, those richest in cement were the least permeable. The permeability of the concrete decreased with its age.

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[1] Wig, R. J., and Bates, P. H., Tests of absorptive and permeable properties of Portland cement mortars and concretes, together with tests of damp-proofing and waterproofing compounds and materials: Tech. Papers Bur. Standards No. 3, U. S. Dept. Com. and Labor, 1912.

The concrete showed very slight or no decrease in the quantity of water passing, with the continuation of the flow. The 3-inch-thick test piece is slightly less permeable than the 2-inch. Concretes made with sand No. 4 were slightly more permeable than those made with sand No. 5, which contained the greatest percentage of fine materials. The permeability of the concrete was not dependent entirely on the quantity of cement used in proportion to the total aggregate, but depended also upon the ratio of coarse aggregate to fine aggregate.

In the tests for absorption, the richer the mixture in cement the less the absorption of the quaking-consistency mortars, but the richness had less effect in the damp-consistency mortars. The absorption was less in the quaking-consistency mortars than in the damp-consistency mortars. The absorption increased with age from the first to the second week in the damp-consistency mortars, but decreased from the second to the twenty-sixth week.

For the tests of damp-proofing and waterproofing compounds and materials 40 different compounds were purchased in the open market and several void-filling materials were obtained. A complete record of each compound is reported as to its character, chemical analysis, method of application, result of physical tests, and noted peculiar characteristics. The compounds are of two general classes: Waterproofing compounds for preventing the flow of water through masonry where subjected to a hydrostatic head, as in reservoirs, cisterns, tunnels, etc.; and damp-proofing compounds for overcoming dampness resulting from the capillary attraction and absorptive qualities of masonry, preventing dampness in habitations, and the disfigurement of exterior and interior surfaces of brick, stone, and concrete walls and interior plastering and decorations due to staining and efflorescence. The Portland cement and sand used throughout these series of tests was the same as that used in the tests of mortar and concrete.

The details of these tests are extremely interesting, but space forbids their being reviewed here. The general conclusions, however, may be summarized as follows, the first series of tests on plain mortar and concrete being correlated with those made with mortar and concrete that had been treated with the various waterproofing and damp-proofing compounds:

Portland cement mortar and concrete may be made practically water-tight or impermeable (as is defined below) to any hydrostatic head up to 40 feet without the use of any of the so-called "integral" waterproofing materials, but in order to obtain such impermeable mortar or concrete considerable care should be exercised in selecting good materials as aggregate and proportioning them in such a manne as to obtain a dense mixture. The consistency of the mixture shoul be wet enough so that it can be puddled, the particles flowing int position without tamping. The mixture should be well spade against the forms when placed so as to avoid the formation of pocket on the surface.

The addition of so-called "integral" waterproofing compound will not compensate for lean mixtures, nor for poor materials, nor fo poor workmanship in the fabrication of the concrete. Since i practice the inert integral compounds (acting simply as void-fillin material) are added in such small quantities, they have very littl or no effect on the permeability of the concrete. If the same care i taken in making the concrete impermeable without the addition of waterproofing materials as is ordinarily taken when waterproofing materials are added, an impermeable concrete can be obtained.

The terms "permeability," "absorption," and "damp proof" should not be confused. A mortar or concrete is impermeable (not necessarily damp proof) when it does not permit the passage or flow of water through its pores or voids. The absorption of a mortar or concrete is the property of drawing in or engrossing water into its pores or voids by capillary action or otherwise. If the pores or voids between the grains or particles or in the individual grains are sufficiently large and connected from surface to surface of the wall, the concrete will be permeable to water. If the pores or voids are very minute, but connect one with another, theoretically they may act as capillary tubes, absorbing or drawing in and filling themselves with water; but the capillary forces will tend to hold the water in the pores and will prevent the passage or flow of water, even though one surface of the wall may be exposed to a considerable hydrostatic pressure. For all practical purposes a wall under such conditions would be considered perfectly water-tight and impermeable, although it may be highly absorptive. If these minute pores do act as capillary tubes and are never minute enough to prevent capillary action, the moisture either as water or water vapor would in time penetrate entirely through and fill a concrete wall, no matter what the thickness or composition. In such a case the capillary forces would not permit an actual flow of water, but these forces may carry moisture, entirely filling the wall, and, unless evaporation is retarded, the opposite face of the wall would appear dry. In such a case the concrete would be considered impermeable, but not damp proof.

The damp-proofing tests as conducted would indicate that Portland cement mortars can be made not only impermeable but damp proof as well, as defined above, without the use of any damp-proofing or waterproofing compound. However, these tests should be interpreted with caution, as the evaporation may have been sufficient to care for the slight amount of moisture coming through the test pieces without indication on the filter paper. Thus it can not be stated that if a material were used which was damp proof according to this test, if used as a basement wall, one surface being constantly exposed to moisture and the other surface in an inclosed room where there would be little or no circulation of air, that the inferior surface would not appear damp and the atmosphere become saturated with moisture. The tests of coating materials as damp-proofing mediums can be considered as only preliminary, but the results, considered along with the chemical discussion, throw some light on their comparative merits. The mortar used in these tests was perhaps too coarse and too absorptive for a fair test. The purpose of the rough surface was to test the flowing qualities of the coating, and it would seem that many of the failures may be due to the poor or imperfect spreading and adhesive quality. Several of the compounds deteriorated and proved their unfitness for the purpose intended.

Well-graded sands containing considerable graded fine material are preferable for making impermeable concrete, but if such is not to be had, fine material in the form of hydrated lime, finely ground clay, or an additional quantity of cement will be found of value.

Where Portland cement mortar is used as a plaster coat, if sufficient cement be used and the sand contain sufficient fine material (or a fine material be added) and the mortar be placed without joints and well troweled (care being taken not to over-trowel, which may cause crazing), the coating will be effective as an impermeable medium without the use of any waterproofing compound.

As a precaution, under certain conditions, it is undoubtedly desirable to use bituminous or similar coatings, even on new work, as protection where cracks may occur due to settling of foundation or expansion and contraction caused by temperature changes. In large or exposed work it is practically impossible to prevent some cracks, but where cracks can be prevented no coating whatever is required to make the structure impermeable.

None of the integral compounds tested materially reduced the absorption of the mortars before they were dried by heating at 212° F. Thus they would have little or no practical value. But some of the so-called integral waterproofing compounds did decrease the absorption obtained after drying the mortars at 212° F., and the rate of absorption was much slower in these cases. The addition of hydrated lime and clays seemed to have little or no effect on the absorption.

The addition of any of the compounds tested to a mortar in the quantities used in these tests does not seriously affect the compressive or tensile strength. The addition of the inert void fillers to mortars, as used in these tests, up to 20 per cent of the volume of cement increases the compressive strength.

RELATIONS OF CEMENTS TO ALKALIES AND SEA WATER.

Much of the investigation in this field has thus far been directed toward ascertaining the weak points in the constitution of Portland cement as indicated by the exposure to sea water and to providing substitutes for the supposed faulty ingredients. Both the alumina and the lime have been considered vulnerable materials. No practical substitute has been discovered for the whole of either of these substances. The excess lime can be taken up by the addition of puzzolanic materials such as trass, tuff, slag, etc., and alumina can be in large part replaced by iron oxide. It has been claimed, especially by German investigators, that iron-ore cements practically free from alumina should be particularly suitable as marine cements. The alumina in cement probably forms compounds with the soluble sulphates and with calcium hydroxide, but, on the other hand, if the alumina is entirely eliminated the cement will lack hydraulic properties.

Tests of iron-ore cements and of various Portland cements, both in sea water and in fresh water, extending over 52 weeks made at the Atlantic City structural materials laboratories, organized by the United States Geological Survey but more recently part of the Bureau of Standards,[1] are cited as evidence that the so-called iron-ore cements do not show any superiority over the Portlands in compression; and taking the results in general it can not be positively stated that the iron-ore cements show much superiority over the regular Portlands. The behavior of white Portland cement containing but

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[1] Bates, P. H., Review of the present status of iron-ore cements: Adv. Paper, Nat. Assoc. Cement Users, 1912, 12 pp.

0.55 per cent Fe_2O_3 and 8.61 per cent alumina was very creditable and is contradictory to the theory that high iron oxide resists sea water the better. Tests also showed that "Eisenportland" cement—a mixture of slag with Portland cement—showed some retrogression but not so much as true slag cement does. Mr. Bates finds that the foreign literature dealing with iron-ore cements is rather indefinite with regard to quantitative results, but that in the case of the Eisenportland cements the published results are more positive and favorable. Mr. Bates suggests that these high-silica cements should therefore receive more attention by the investigator, the manufacturer, and the consumer.

A series of experiments have recently been made by H. E. Brown[1] at Yorktown, Va., on cements produced from ferruginous shell marl, and from shell marl and clay in southeastern Virginia. These cements contained generally from 1.66 to 6.1 times as much Fe_2O_3 as Al_2O_3; in a few cases the ratio fell below 1. Mr. Brown recommends the name "marine" cements for such low-alumina cements, in view of the fact that they are designed for use in concrete marine structures. It was found advisable to add accelerators on account of the slow set of these cements, and the aluminates of calcium proved the most satisfactory accelerators. Mr. Brown states in conclusion that the problem of the underlying causes for the action of sea water is so complex that it is not surprising that there are many and opposing views held by able investigators who have spent much time and earnest effort in the attempt to solve it. He also sums up as follows the chemical and physical action which stands out clearly in this work, extending over nearly two years:

> When disintegrating effects occur in concrete exposed to the action of sea water, due to wind, wave, and tide, these disintegrating effects may be rightly divided into two main causes—mechanical and chemical. Mechanical action is influenced (first) by alternate drying and wetting of the surfaces, due to wind, wave, and tidal action; (second) abrasions from ice or floating objects; (third) formation of expansive crystals where freezing occurs, or where double salts may be formed within the concrete body.
>
> This brings us to the second main cause of disintegration, namely, chemical action, since the formation of the double salts as calcium aluminum sulphate occupy more space than the original compounds. The dissolving, replacing, and formation of these new crystalline substances act in the same manner as ice crystals within the rocks. Such ice crystals have been very effective in producing disintegration of the ancient rocks covering the earth's surface.
>
> The hydraulic cements which are best fitted to withstand satisfactorily all disintegrating effects of sea water (excepting those which are purely mechanical) are those which give the greatest density of concrete structure and which are relatively high in silica, low in magnesia and sulphur trioxide, and in which the content of alumina does not exceed that of the ferric oxide.

Other experiments have recently been conducted by Edwin C. Eckel[2] at Norfolk, Va., on ferro-Portland cements made from glauconite (greensand) from the Atlantic Coastal Plain, mixed with shell marl and also with impure limestone. These ferro-Portlands carry 3.3 per cent to 5.92 per cent alumina, and 7.38 per cent to 8.97 per cent iron oxide, or the ratio varies between 1 : 1.4 and 1 : 2.4. The lime is normal in some but low in those made from impure limestone. Since these experiments have been described elsewhere, only a few of the leading features need be mentioned here. The tests on these cements showed good results with sea water as compared with fresh water, but unfortunately no parallel experiments with ordinary low-iron high-alumina cements are recorded. Mr. Eckel gives some space to the discussion of comparative costs of manufacturing normal Portland cement and ferro-Portland cement from iron ore and limestone, and from greensand and limestone, in which the advantage is with the latter type. The possible recovery of potash as a by-product from the greensand is suggested as a further factor in reducing costs.

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[1] Brown, H. E., Marine, or iron-ore cements: Adv, Paper Nat. Assoc. Cement Users, 1912, 16 pp.

[2] Eckel, E. C., Ferrite cements and ferro-Portlands: Eng. News, Aug. 3, 1911, pp. 157-158.

There is little doubt that the manufacture of special cements represented by the various high-iron and high-silica types are destined to exert an increasing influence on the cement industry in the future.

IMPORTANCE OF TESTING CEMENT.

The importance of testing cement just before using it is generally recognized by large consumers, but it is entirely overlooked by the great majority of those who employ cement on a small scale, as in building sidewalks and small houses, cementing cellars, etc. These suggestions are therefore addressed only to consumers who have never looked into the matter of having tests made. On account of the nature of the manufacture of cement from raw materials which are rarely constant in composition, the resulting product can hardly be expected to be invariably uniform. Manufacturers generally take precautions to prevent the shipment of defective cement, but the tests made at the mill can not always reveal imperfections in manufacture, and, besides, the properties in cement are subject to alteration after leaving the mill.

In order best to ascertain the quality of cement shipped the tests should be made after the cement arrives on the work, and they should be made with the greatest care and only by responsible and trained men in laboratories where the instruments have been properly standardized.

For the purpose of correcting any misapprehension that may arise, it should be stated here that the United States Geological Survey maintains no testing laboratories and does not make any kind o tests of cement or of any other structural materials either free or fo compensation. Such work should be intrusted to private commercial laboratories, such as are in operation in all the large cities of th United States.

NATURAL CEMENT.

DEFINITION AND CHARACTERISTICS.

Natural cements are the product of burning an impure limestone containing from 15 to 40 per cent of silica, alumina, and iron oxide, a a comparatively low temperature, about that of ordinary lime burning. The operation can therefore be carried on in a kiln closel resembling an ordinary limekiln. During the burning the carbo dioxide of the limestone is almost entirely driven off, and the lim combines with the silica, alumina, and iron oxide, forming a mas containing silicates, aluminates, and ferrites of lime. If the origina limestone contained much magnesium carbonate the burned roc will contain a corresponding amount of magnesia.

The burned mass will not slack if water be added. It is necessary, therefore, to grind it rather fine. After grinding, if the resulting powder (natural cement) be mixed with water it will harden rapidly. This hardening or setting will also take place under water. Natural cements differ from ordinary limes in two notable ways—(1) the burned mass does not slack on the addition of water; (2) the powder has hydraulic properties; that is, if properly prepared it will set under water.

Natural cements differ from Portland cements in the following important particulars:

1. Natural cements are not made from especially prepared and finely ground artificial mixtures but from natural rock.
2. Natural cements are burned at a lower temperature than Portland, the mass in the kiln never being heated high enough to reach the fusing or clinkering point.
3. Natural cements after burning and grinding are usually yellow to brown in color and relatively light in weight, having a specific gravity of 2.7 to 3.1; Portland cement is commonly blue to gray in color and heavier, its specific gravity ranging from 3 to 3.2.
4. Natural cements set more rapidly than Portland cement but do not quickly attain as high a tensile strength, although long-time tests have shown that ultimately natural cement may show equal or even greater tensile strength.
5. Different brands of natural cement vary greatly in composition. Natural cements generally carry less lime and more magnesia than Portland cement.

PRODUCTION.

The natural cement produced in the United States during 1911 amounted to 926,091 barrels, valued at $378,533, as compared with an output of 1,139,239 barrels, valued at $483,006, in 1910, a decrease in 1911 of 213,148 barrels, or 18.7 per cent, in quantity and of $104,473, or 21.6 per cent, in value. The average price of natural cement per barrel at the mills was not quite 40.9 cents in 1911 and 42.4 cents in 1910.

PRODUCTION BY STATES.

In the following table the natural cement production of 1911 is classified by States, or groups of States, the figures for 1910 being given for comparison:

Production of natural cement in 1910 and 1911, by States.

State.	1910			State.	1911		
	Producing plants.	Quantity (barrels).	Value.		Producing plants.	Quantity (barrels).	Value.
New York	5	304,598	$150,952	New York	4	429,832	$178,937
Pennsylvania	3	196,331	56,777	Pennsylvania	2		
Illinois	1	315,823	115,471	Illinois	1	257,859	86,370
Indiana	2			Indiana	1		
Ohio	1			Ohio	1		
Georgia	2	37,487	18,931	Minnesota	2	192,000	86,640
Kentucky	1			Kansas	1		
Minnesota	2	285,000	140,875	Georgia	2	46,400	26,586
Kansas	1			Texas	1		
Texas	1						
Total	19	1,139,239	483,006	Total	15	926,091	378,533

THE NATURAL-CEMENT INDUSTRY, 1818-1911.

The following table contains statistics relative to the natural-cement industry since its beginning in this country in 1818. It will be seen that the natural-cement trade reached its greatest prosperity in the period 1887–1903, inclusive, its year of maximum output being 1899, when 9,868,179 barrels of natural cement were manufactured in the United States. Beginning with 1904, the industry has shown a continuous decline in production each year, and its production for 1911 is the lowest on record since before 1880.

Production of natural cement in the United States, 1818–1911, in barrels.

1818–1829	300, 000	1894	7, 563, 488
1830–1839	1, 000, 000	1895	7, 741, 077
1840–1849	4, 250, 000	1896	7, 970, 450
1850–1859	11, 000, 000	1897	8, 311, 688
1860–1869	16, 420, 000	1898	8, 418, 924
1870–1879	22, 000, 000	1899	9, 868, 179
1880	2, 030, 000	1900	8, 383, 519
1881	2, 440, 000	1901	7, 084, 823
1882	3, 165, 000	1902	8, 044, 305
1883	4, 190, 000	1903	7, 030, 271
1884	4, 000, 000	1904	4, 866, 331
1885	4, 100, 000	1905	4, 473, 049
1886	4, 186, 152	1906	4, 055, 797
1887	6, 692, 744	1907	2, 887, 700
1888	6, 253, 295	1908	1, 686, 862
1889	6, 531, 876	1909	1, 537, 638
1890	7, 082, 204	1910	1, 139, 239
1891	7, 451, 535	1911	926, 091
1892	8, 211, 181		
1893	7, 411, 815	Total	230, 705, 233

With regard to the future of natural cement the Cement Age[1] suggests that more general use be made of blended cements consisting of mixtures of Portland and natural cements. Such a blend consisting of about three parts of natural cement and one part of Portland cement was especially prepared and used in large quantities in building the New York subway, especially in conjunction with sewers This blend was specified by reason of the greater impermeability o the mortar to the attack of sewer gases and the chemicals frequentl occurring in solution and sewage. It is impossible to form a homogeneous or blend mixture, on the job, and to be effective the mixin or blending should take place at the factory. If such blended cement are offered for sale, they should be so labeled as to show exactly wha cements were used and in what proportions they were incorporate with the mixture, in order that no prejudice may arise against thei use on the score of adulteration. In districts where Portland cemen is cheap, as in the Eastern States, the cost of blended cements migh be more than that of ordinary Portlands, but if, owing to their lowe lime content, such blended cements proved superior to ordinary Portlands in work exposed to the injurious action of sea water or wate containing sulphuric and other acids, these advantages ought to warrant their employment even at greater cost. Mention is made of blended cement of another type on another page.

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[1] Cement Age, February, 1912, p. 101.

PUZZOLAN AND OTHER SLAG CEMENTS.

Definition.—The cementing material, known as puzzolan cement, is made by mixing powdered slacked lime with either a volcanic ash or a blast-furnace slag. The product is, therefore, simply a mechanical mixture of two ingredients, as the mixture is not burned at any stage of the process. After mixing, the mixture is finely ground. The resulting powder (puzzolan cement) will set under water.

Puzzolan cements are usually light bluish and of lower specific gravity and less tensile strength than Portland cement.[1]

Collos cement.—The manufacture of a cementing material termed "Collos" cement has recently been begun in America. According to the manufacturers it is produced by a patented process which consists in gradually pouring molten blast-furnace slag—when the composition of the slag is suitable for the purpose—or by pouring the molten material which has been fused directly for the purpose in a blast furnace, upon a rapidly revolving corrugated cylinder, which scatters it in finely distributed particles. While still molten and before they have been collected these particles come in contact with a spray of a relatively small amount of a weak solution of one or more of the soluble salts of the alkaline earths, magnesium sulphate being generally used, and are then cooled and collected and ground to a fine powder. This powder is the finished cement requiring for use additions of only the usual small percentage of insoluble calcium salts added to Portland cement to control the setting time. This is a dry-granulation process, only enough water being used to carry the salt to the molten particles.

The result of this process is a cement which differs essentially from both Portland and puzzolan cements. The specific gravity of the Collos cement is reported to be about 2.88, which is lower than that of Portland cement, and its composition differs in that the Collos carries more silica and alumina and less lime than Portland cement, and may also carry more magnesia, besides small percentages of calcium sulphide and alkalies. Collos cement is made in considerable quantities in Germany and in Scotland, but its manufacture in the United States is confined to one plant at Buffalo, N. Y. The product is reported to be a light-colored, nonstaining cement. The production has been tabulated with that of the other slag cements because there are not the three plants necessary to a separate tabulation of output.

Puzzolan cement was manufactured during 1911 at three plants in the United States—at North Birmingham, Ala., Struthers, Ohio, and Sharon, Pa. The output of puzzolan and Collos cements in 1911 was 93,230 barrels, valued at $77,786. This represents a decrease in quantity of 2,721 barrels, but an increase in value of $14,500. The average price per barrel of these slag cements in 1911 was 83.4 cents; in 1910 it was 66 cents. It is significant that in 1911 the average price of slag cement was only 1 cent less than that of Portland cement.

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[1] Eckel, E. C., Cement materials and industry of the United States: Bull. U. S. Geol. Survey No. 243, 1905, p. 20.

The following table contains the leading facts relative to the puzzolan-cement industry for the five years 1907 to 1911, inclusive:

Statistics of the puzzolan-cement industry, 1907–1911, by States.

	1907	1908	1909	1910	1911
Number of plants reporting production:					
Alabama	1	1	1	1	1
Illinois	1				
Kentucky	1				
Maryland					
New Jersey					
New York[a]	1				1
Ohio	2	2	2	2	1
Pennsylvania	1	1	1	1	1
Total	7	4	4	4	4
Production in barrels	557,252	151,451	160,646	95,951	93,230
Value of production	$443,998	$95,468	$99,453	$63,286	$77,786

[a] Includes production of Collos cement in 1911.

At the close of December, 1911, there were reported 7,600 barrels of puzzolan cement in stock at the mills.

The following table gives the annual production of puzzolan cement in the United States since 1896, when the first output of this cement was reported:

Output of puzzolan cement in the United States, 1896–1911, in barrels.

1896	12,265	1905	382,447
1897	48,329	1906	481,224
1898	150,895	1907	557,252
1899	335,000	1908	151,451
1900	446,609	1909	160,646
1901	272,689	1910	95,951
1902	478,555	1911[1]	93,230
1903	525,896		
1904	303,045	Total	4,495,484

BLENDED CEMENT.

A cement which partakes of the natures of both puzzolan and Portland cements, as described more fully in this report for 1910,[2] is being produced on a large scale in connection with the construction of the Los Angeles Aqueduct in California. It is made by regrinding Portland cement with volcanic tuff, and is called locally "tufa cement." The output of this cement in 1911 was 233,668 barrels, valued at $1.60 per barrel, but it is not included in the total cement production, since the quantity of Portland cement required in the process (50 per cent by volume) was included in the total production of Portland cement in the United States.

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[1] 1911 output includes Collos cement.

[2] Cement: Mineral Resources U. S. for 1910, U. S. Geol. Survey, pt. 2, 1911, p. 487.

PUBLICATIONS ON CEMENT MATERIALS, CEMENT, AND CONCRETE.

UNITED STATES GEOLOGICAL SURVEY.

The following list includes the principal publications on cement and concrete materials by the United States Geological Survey. These Survey publications, except those to which a price is affixed, can be obtained free by applying to the Director, United States Geological Survey, Washington, D. C. The priced publications may be purchased from the Superintendent of Documents, Government Printing Office, Washington, D. C. The Survey does not distribute any other than its own publications.

Adams, G. I., and others, Stratigraphy and paleontology of the upper Carboniferous rocks of the Kansas section: Bull. 211, 1903, 123 pp. 20c.

——— Economic geology of the Iola quadrangle, Kansas: Bull. 238, 1904, 80 pp.

Ball, S. H., Portland cement materials in eastern Wyoming: Bull. 315, 1907, pp. 232–244. 50c.

Bassler, R. S., Cement materials of the Valley of Virginia: Bull. 260, 1905, pp. 531–544. 40c.

Bastin, E. S., The lime industry of Knox County, Me.: Bull. 285, 1906, pp. 393–400. Edition exhausted.

——— Clays of the Penobscot Bay region, Maine: Bull. 285, 1906, pp. 428–431. Edition exhausted.

Branner, J. C., Clays of Arkansas: Bull. 351, 1908, 247 pp.

Burchard, E. F., Portland cement materials near Dubuque, Iowa: Bull. 315, 1907, pp. 225–231. 50c.

——— Concrete materials produced in the Chicago district: Bull. 340, 1908, pp. 383–410. 30c.

——— Structural materials available in the vicinity of Austin, Tex.: Bull. 430, 1910, pp. 292–316.

——— Cement: Mineral Resources U. S. for 1909, pt. 2, 1911, pp. 433–452. 75c.

——— Cement: Mineral Resources U. S. for 1910, pt. 2, 1911, pp. 469–535.

Catlett, C., Cement resources of the Valley of Virginia: Bull. 225, 1904, pp. 457–461. 35c.

Clapp, F. G., Limestones of southwestern Pennsylvania: Bull. 249, 1905, 52 pp.

Crider, A. F., Cement resources of northeast Mississippi: Bull. 260, 1905, pp. 510–521. 40c.

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Darton, N. H., Geology and water resources of the northern portion of the Black Hills and adjoining regions in South Dakota and Wyoming: Prof. Paper 65, 1909, 104 pp.

——— Structural materials in parts of Oregon and Washington: Bull. 387, 1909, 36 pp.

——— Cement materials in Republican Valley, Nebraska: Bull. 430, 1910, pp. 381–387.

——— and Siebenthal, C. E., Geology and mineral resources of the Laramie Basin, Wyoming: Bull. 364, 1908, 81 pp.

Duryee, E., Tests of cement materials from Gila River, Arizona: Water-Supply Paper 33, 1900, pp. 82–90. 15c.

——— Cement investigations in Arizona: Bull. 213, 1903, pp. 372–380. 25c.

Eckel, E. C., The materials and manufacture of Portland cement: Senate Doc. 19, 58th Cong., 1st sess., 1903, pp. 2–11.

——— Cement-rock deposits of the Lehigh district: Bull. 225, 1904, pp. 448–450. 35c.

——— Cement materials and cement industries of the United States: Bull. 243, 1905, 395 pp. Edition exhausted. Available in libraries of cities and educational institutions.

——— The American cement industry: Bull. 260, 1905, pp. 496–505. 40c.

——— Portland cement resources of New York: Bull. 260, 1905, pp. 522–530. 40c.

——— Cement resources of the Cumberland Gap district, Tennessee-Virginia: Bull. 285, 1906, pp. 374–376. Edition exhausted.

——— Cement: Mineral Resources U. S. for 1908, pt. 2, 1909, pp. 441–453. 80c.

Eckel, E. C., and Burchard. E. F., Portland Cement materials and industry of the United States: Bull. 522 (in preparation).

——— and Crider, A. F., Geology and cement resources of the Tombigbee River district, Mississippi-Alabama: Senate Doc. 165, 58th Cong., 3d sess., 1905, 21 pp.

Fenneman, N. M., Geology and mineral resources of the St. Louis quadrangle, Missouri-Illinois: Bull. 438, 1911, 73 pp.

Humphrey, R. L., The effects of the San Francisco earthquake and fire on various structures and structural materials: Bull. 324, 1907, pp. 14–61. 50c.

——— Organization, equipment, and operation of the structural-materials testing laboratories at St. Louis, Mo.: Bull. 329, 1908, 85 pp. 20c.

——— Portland cement mortars and their constituent materials: Results of tests, 1905 to 1907: Bull. 331, 1908, 130 pp. 25c.

——— The strength of concrete beams; results of tests made at the structural-materials testing laboratories: Bull. 344, 1908, 59 pp. 10c.

——— The fire-resistive properties of various building materials: Bull. 370, 1909, 99 pp. 30c.

Landes, H., Cement resources of Washington: Bull. 285, 1906, pp. 377–383. Edition exhausted.

Lippincott, J. B., Manufacture of Portland cement in southern California: Water-Supply Paper 60, 1902, pp. 135–137. 15c.

Martin, G. C., The Niobrara limestone of northern Colorado as a possible source of Portland cement material: Bull. 380, 1909, pp. 314–326.

Pepperberg, L. J., Cement material near Havre, Mont.: Bull. 380, 1909, pp. 327–336.

Richardson, G. B., Portland cement materials near El Paso, Tex.: Bull. 340, 1908, pp. 411–414. 30c.

Ries, H., Clays of Illinois: Prof. Paper 11, 1903, pp. 94–97. 40c.

Russell, I. C., The Portland cement industry in Michigan: Twenty-second Ann. Rept., pt. 3, 1902, pp. 620–686. $2.

Schrader, F. C., Geology of the Independence quadrangle, Kansas: Geol. Atlas, Folio 159, 1907. 25c.

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Sewell, J. S., The effects of the San Francisco earthquake on buildings, engineerin structures, and structural materials: Bull. 324, 1907, pp. 62–130. 50c.

Siebenthal, C. E., The Bedford oolitic limestone (Indiana): Nineteenth Ann Rept. U. S. Geol. Survey, pt. 6 continued, 1898, pp. 292–296.

Smith, E. A., The Portland cement materials of central and southern Alabama Senate Doc. 19, 58th Cong., 1st sess., 1903, pp. 12–23.

——— Cement resources of Alabama: Bull. 225, 1904, pp. 424–447. 35c.

Taff, J. A., Chalk of southwestern Arkansas, with notes on its adaptability to th manufacture of hydraulic cements: Twenty-second Ann. Rept., pt. 3, 1902, pp 687–742. $2.

Udden, J. A., Oolitic limestone industry at Bedford and Bloomington, Ind.: Bul 430, 1910, pp. 335–345.

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Cox, Alvin J., Volcanic tuff as a construction and a cement material: Philippin Jour. Sci., Bureau Sci., Manila, P. I., November, 1908, pp. 391–406.

——— Philippine raw cement materials: Philippine Jour. Sci., Bureau Sci., Manil P. I., May, 1909, pp. 211–229.

Humphrey, R. L., and Losse, L. H., The strength of reenforced concrete beams-results of 333 beams: Tech. Paper Bur. Standards No. 2, 1912, 200 pp.

Office of Public Roads, The construction of concrete fence posts: Farmers' Bul No. 403, U. S. Dept. Agr., 1910, 31 pp.

——— Use of concrete on the farm: Farmers' Bull. No. 461, U. S. Dept. Agr., 191 23 pp.

Page, L. W., Oil-mixed Portland cement concrete: Bull. Office Pub. Roads No. 4 U. S. Dept. Agr., 1912, 28 pp.

Reibling, W. C., and Reyes, F. D., Physical and chemical properties of Portla cement: Philippine Jour. Sci., Bureau Sci., Manila, P. I., December, 1910, p 367–417, June, 1911, pp. 207–251.

United States Government, Specification for Portland cement: Circ. Bur. Stan ards No. 33, 1912, 28 pp.

Wig, R. J., The effect of high-pressure steam on the crushing strength of Portla cement mortar and concrete: Tech. Paper Bur. Standards No. 5, 1912, 25 pp.

Wig, R. J., and Bates, P. H., Tests of the absorptive and permeable properties of ortland cement mortars and concretes, together with tests of damp-proofing and aterproofing compounds and materials: Tech. Paper Bur. Standards No. 3, 127 p., 1912.

Wormley, P. L., jr., Cement mortars and concrete—preparation and use for farm urposes. Farmers' Bull. No. 235, U. S. Dept. Agr., 1905, 32 pp.

STATE GEOLOGICAL SURVEYS.

From time to time investigative work is done by certain of the tate geological surveys, and many detailed reports have been pubshed on important local deposits. The surveys of the following tates have made special studies of local cement resources: Alabama, rkansas, California, Georgia, Illinois, Indiana, Iowa, Maryland, lichigan, Mississippi, Missouri, New Jersey, New York, North akota, Ohio, Oklahoma, South Dakota, Vermont, Virginia, Washngton, and West Virginia. Certain other States have done a little ork on their cement materials.

The most important of the State reports are listed below:

labama: Smith, E. A., and Ries, H., Preliminary report on the clays of Alabama: Bull. Alabama Geol. Survey No. 6, 1900, 220 pp.

Smith, E. A., and Eckel, E. C., The cement resources of Alabama, and the materials and manufacture of Portland cement: Bull. Alabama Geol. Survey No. 8, 1904, 93 pp.

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McCallie, S. W., Marbles of Georgia: Bull. Georgia Geol. Survey No. 1, 2d ed., 1907, 126 pp.

llinois: Cady, G. H., Cement-making materials in the vicinity of La Salle: Bull. Illinois Geol. Survey No. 8, 1907, pp. 127–134.

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Beyer, S. W., and Williams, I. A., The materials and manufacture of Portland cement: Iowa Geol. Survey, vol. 17, 1906, pp. 29–89.

Kansas: Haworth, E., Mineral resources of Kansas, 1897.

Kentucky: Gardner, J. H., Report of progress for 1904–05; Kentucky Geol. Survey, 1906, pp. 18–20.

Maryland: Ries, H., Report on the clays of Maryland: Repts. Maryland Geol. Survey, vol. 4, 1902, pp. 203–505.

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CLAY-WORKING INDUSTRIES.

By Jefferson Middleton.

INTRODUCTION.

The present report deals with the products of the clay-working industries, with the exception of the section on clay mining; hence the tables are made up to show the products of clay manufactured and not the production of clay.

The year 1911 in the clay-working industries was one of retrogression so far as the total value of product is concerned, the total value of all clay products marketed in the year being $162,236, 181, compared with $170,115,974 in 1910, a decrease of $7,879,793, or 4.63 per cent. Compared with 1909 there was a decrease of $4,085-032, or 2.46 per cent.

Of the two great divisions of the industry, (1) brick and tile and (2) pottery, the latter showed an increase. The decrease in the brick and tile industry was $8,613,675, or 6.32 per cent. The increase in the pottery industry was $733,882, or 2.17 per cent.

In the brick and tile industry decreases were shown in both the quantity and value of common brick, in the number of vitrified paving brick, in the value of fancy or ornamental brick, in the quantity and value of fire brick, and in the value of drain tile and architectural terra cotta. Increases were recorded in the value of vitrified paving brick, in the quantity and value of front brick, in the value of enameled brick, stove lining, sewer pipe, fireproofing, and the miscellaneous items.

The decrease in the common-brick output may be partly accounted for by the increased use of hollow block or tile for the construction of large buildings and even of dwelling houses. This form of construction offers many advantages, among which are economy in construction, the ease and rapidity with which it can be put in the wall, and its nonconductivity. All of these should be factors in the extension of its use. Structures made of hollow tile may be faced either with brick, stucco, or other material. It seems, therefore, likely that the production of common brick will not show rapid increase in the future, and it is probable that the use of hollow tile or block will largely increase.

The value of draintile increased constantly for 10 years up to 1910 and then showed a large decrease—15.05 per cent—the largest proportional decrease of any clay product in 1911. This decrease may be ascribed in part at least to the unusually dry season of the year.

Fire brick being used almost exclusively in the iron and steel and coke-making industries, its production naturally rises and falls with the conditions of those industries. As these industries in 1911 showed considerable falling off, fire brick also decreased in quantity and value.

In the pottery industry every item of the classification, except one, showed an increase. The imports of pottery decreased and the proportion of domestic production to consumption was the highest ever recorded, 78.93 per cent. The exports of high-grade domestic pottery, though small, increased, and the exports of all clay products increased 38.61 per cent.

In statements to the Survey, quantities are reported for common brick, front brick, and vitrified paving brick, but not for fancy or ornamental and enameled brick. The average price per thousand decreased 10 cents on common brick and 38 cents on front brick; on vitrified paving brick the average increased 35 cents. The average value of product per firm reporting in 1911 was $35,055 compared with $34,612 in 1910.

Never before in the history of the clay-working industry has there been so much done to advertise the advantages of burned clay products as structural materials. The publicity campaign inaugurated and carried on by the Building Brick Association by advertising in leading popular magazines the adaptability of brick to the use of artistic structures is an illustration of the means employed to give life to the "back to brick" movement.

The economy and necessity of fireproof construction is being realized more and more, and no material for this purpose is so cheap or so good as burned clay products. The experience gained in some of the recent conflagrations has served to emphasize the advantage of burned clay as a fireproof building material.

Efforts are also being made constantly to improve the quality of clay products in texture, color, uniformity of size of brick, etc. Brick and terra cotta of almost any desired shape, color, and texture may now be obtained, permitting the architect a wide choice of combinations.

One of the most important features of the brick industry along Hudson River, in 1911, and perhaps one of the most important steps in the history of the common brick industry, was the organization in the middle of the brickmaking season of 1911, of the Greater New York Brick Co. This company, composed of a large proportion o the common-brick makers along Hudson River, was organized fo the purpose of cheapening the cost of brick manufacture by purchasing supplies in large quantities and to reduce the cost of marketing the product. The company disclaims any intention to contro prices. Another of the objects of the company is to enhance th quality of the brick made along the Hudson, by the introduction o improved methods of manufacture.

There were no widespread strikes in the clay-working industries i 1911. The most serious one was among the brickmakers of Chicago This strike was not confined to the brickmakers but involved th building trades generally. The strike was settled after lastin nearly six weeks. The outcome was rather favorable to the manufacturers. The men returned to work at the old wage scale, but wit a shorter working day and with a three-year agreement. This strik lasted long enough to interfere somewhat seriously with the buildin activities of Chicago. Along Hudson River in the spring there wer small strikes, lasting for a day or so, but they were of no consequenc

ACKNOWLEDGMENTS.

The writer again desires to thank the clay workers of the countr on behalf of the Survey, for their cooperation, without which th report would be impossible.

The State geological surveys of Alabama, Georgia, Illinois, Iowa, Kansas, Kentucky, Maryland, Michigan, Missouri, New Jersey North Carolina, Oklahoma, Oregon, Pennsylvania, Texas, Virginia, Washington, and Wisconsin have cooperated in the collection of the statistics in these States, the completeness of the returns and the earlier publication of the results being due largely to their efforts.

Thanks are also extended to the clay-working press for its support and appreciation and to the officials who have supplied information concerning the building operations of the various cities of the country.

PRODUCTION.

PRODUCTION BY STATES.

In the following table will be found a statement of the value of the clay products in the United States in 1910 and 1911, by States:

Value of the products of clay in the United States in 1910 and 1911, by States and Territories.

State or Territory.	1910			1911		
	Brick and tile.	Pottery.	Total.	Brick and tile.	Pottery.	Total.
Alabama	$1,645,313	$22,246	$1,667,559	$1,918,606	$28,496	$1,947,102
Arizona	126,777	....	126,777	106,882	....	106,882
Arkansas	550,105	28,350	578,455	465,143	15,500	480,643
California	4,744,968	97,423	4,842,391	4,757,530	158,336	4,915,866
Colorado	1,982,827	50,887	2,033,714	1,566,636	40,073	1,606,709
Connecticut and Rhode Island	1,568,486	(*a*)	1,568,486	1,257,339	(*a*)	1,257,339
Delaware	216,555	....	216,555	200,610	....	200,610
District of Columbia	242,861	(*a*)	242,861	227,520	(*a*)	227,520
Florida	237,268	....	237,268	217,535	....	217,535
Georgia	2,510,740	21,298	2,532,038	2,612,050	24,330	2,636,380
Idaho and Nevada	347,437	....	347,437	198,479	....	198,479
Illinois	14,331,414	844,747	15,176,161	13,353,200	979,811	14,333,011
Indiana	7,143,306	956,704	8,100,010	5,996,034	1,004,737	7,000,771
Iowa	5,310,706	17,535	5,328,241	4,396,555	36,319	4,432,874
Kansas	2,661,527	(*a*)	2,661,527	2,360,262	(*a*)	2,360,262
Kentucky	2,418,116	149,421	2,567,537	2,254,000	114,094	2,368,094
Louisiana	546,873	(*a*)	546,873	531,949	(*a*)	531,949
Maine	599,881	(*a*)	599,881	619,214	(*a*)	619,214
Maryland	1,614,348	233,925	1,848,273	1,518,023	254,411	1,772,434
Massachusetts	1,469,018	238,395	1,707,413	1,471,761	228,526	1,700,287
Michigan	2,083,525	112,697	2,196,222	1,953,442	130,490	2,083,932
Minnesota	1,901,296	(*a*)	1,901,296	1,693,478	(*a*)	1,693,478
Mississippi	613,009	19,990	632,999	664,176	23,660	687,836
Missouri	7,058,705	29,061	7,087,766	6,269,145	5,208	6,274,353
Montana	411,824	(*a*)	411,824	260,547	(*a*)	260,547
Nebraska	938,827	....	938,827	795,894	....	795,894
New Hampshire	566,121	(*a*)	566,121	430,748	(*a*)	430,748
New Jersey	9,245,854	8,588,455	17,834,309	9,776,287	8,401,941	18,178,228
New Mexico	129,275	(*a*)	129,275	174,651	(*a*)	174,651
New York	9,778,288	2,093,661	11,871,949	8,006,012	2,178,364	10,184,376
North Carolina	1,208,674	14,990	1,223,664	1,271,570	8,556	1,280,126
North Dakota	227,455	....	227,455	210,616	....	210,616
Ohio	17,231,236	14,294,712	31,525,948	17,888,630	14,775,265	32,663,895
Oklahoma	920,921	....	920,921	756,639	....	756,639
Oregon	876,632	(*a*)	876,632	1,081,025	(*a*)	1,081,025
Pennsylvania	19,814,355	2,279,930	22,094,285	18,113,216	2,156,817	20,270,033
Porto Rico	27,773	(*a*)	27,773	19,528	(*a*)	19,528
South Carolina	696,600	7,990	704,590	663,674	6,120	669,794
South Dakota	71,200	....	71,200	61,365	....	61,365
Tennessee	1,205,108	209,180	1,414,288	1,187,961	197,139	1,385,100
Texas	2,744,845	119,085	2,863,930	2,527,502	132,417	2,659,919
Utah	864,258	(*a*)	864,258	548,955	(*a*)	548,955
Vermont	89,253	....	89,253	86,466	....	86,466
Virginia	1,793,270	46,417	1,839,687	1,726,491	13,409	1,739,900
Washington	3,023,854	(*a*)	3,023,854	2,840,372	(*a*)	2,840,372
West Virginia	1,322,457	2,675,588	3,998,045	1,453,218	2,880,202	4,333,420
Wisconsin	1,167,918	8,965	1,176,883	1,149,539	8,600	1,158,139
Wyoming	50,237	....	50,237	77,146	....	77,146
Other States	....	623,026	623,026	....	715,739	715,739
Total	136,331,296	33,784,678	170,115,974	127,717,621	34,518,560	162,236,181
Per cent of total	80.15	19.85	100.00	78.72	21.28	100.00

[a] Included in "Other States."

This table shows that the brick and tile products as classified by this Survey continue to constitute approximately four-fifths and the pottery products one-fifth of the total. These proportions have been maintained for many years, though the proportion of pottery is increasing. Every State and Territory, Alaska and Hawaii excepted, is a producer of burned clay. In Nevada and Rhode Island there was not a sufficient number of producers to permit the publication of State totals without disclosing individual returns, so that the statistics for these States have been combined with those of contiguous States.

Value of the clay products of the United States, by States and Territories, in 1910 and 1911, showing increase or decrease, with percentage of increase or decrease.

State or Territory.	1910	1911	Increase (+) or decrease (−) in 1911.	Percentage of increase (+) or decrease (−) in 1911.
Alabama	$1,667,559	$1,947,102	+ $279,543	+16.76
Arizona	126,777	106,882	− 19,895	−15.69
Arkansas	578,455	480,643	− 97,812	−16.91
California	4,842,391	4,915,866	+ 73,475	+ 1.52
Colorado	2,033,714	1,606,709	− 427,005	−21.00
Connecticut and Rhode Island	1,568,486	1,257,339	− 311,147	−19.84
Delaware	216,555	200,610	− 15,945	− 7.36
District of Columbia	242,861	227,520	− 15,341	− 6.32
Florida	237,268	217,535	− 19,733	− 8.32
Georgia	2,532,038	2,636,380	+ 104,342	+ 4.12
Idaho and Nevada	347,437	198,479	− 148,958	−42.87
Illinois	15,176,161	14,333,011	− 843,150	− 5.56
Indiana	8,100,010	7,000,771	−1,099,239	−13.57
Iowa	5,328,241	4,432,874	− 895,367	−16.80
Kansas	2,661,527	2,360,262	− 301,265	−11.32
Kentucky	2,567,537	2,368,094	− 199,443	− 7.77
Louisiana	546,873	531,949	− 14,924	− 2.73
Maine	599,881	619,214	+ 19,333	+ 3.22
Maryland	1,848,273	1,772,434	− 75,839	− 4.10
Massachusetts	1,707,413	1,700,287	− 7,126	− .42
Michigan	2,196,222	2,083,932	− 112,290	− 5.11
Minnesota	1,901,296	1,693,478	− 207,818	−10.93
Mississippi	632,999	687,836	+ 54,837	+ 8.66
Missouri	7,087,766	6,274,353	− 813,413	−11.48
Montana	411,824	260,547	− 151,277	−36.73
Nebraska	938,827	795,894	− 142,933	−15.22
New Hampshire	566,121	430,748	− 135,373	−23.91
New Jersey	17,834,309	18,178,228	+ 343,919	+ 1.93
New Mexico	129,275	174,651	+ 45,376	+35.10
New York	11,871,949	10,184,376	−1,687,573	−14.21
North Carolina	1,223,664	1,280,126	+ 56,462	+ 4.61
North Dakota	227,455	210,616	− 16,839	− 7.40
Ohio	31,525,948	32,663,895	+1,137,947	+ 3.61
Oklahoma	920,921	756,639	− 164,282	−17.84
Oregon	876,632	1,081,025	+ 204,393	+23.32
Pennsylvania	22,094,285	20,270,033	−1,824,252	− 8.26
Porto Rico	27,773	19,528	− 8,245	−29.69
South Carolina	704,590	669,794	− 34,796	− 4.94
South Dakota	71,200	61,365	− 9,835	−13.81
Tennessee	1,414,288	1,385,100	− 29,188	− 2.06
Texas	2,863,930	2,659,919	− 204,011	− 7.12
Utah	864,258	548,955	− 315,303	−36.48
Vermont	89,253	86,466	− 2,787	− 3.12
Virginia	1,839,687	1,739,900	− 99,787	− 5.42
Washington	3,023,854	2,840,372	− 183,482	− 6.07
West Virginia	3,998,045	4,333,420	+ 335,375	+ 8.39
Wisconsin	1,176,883	1,158,139	− 18,744	− 1.59
Wyoming	50,237	77,146	+ 26,909	+53.56
Other States	[a] 623,026	[a] 715,739	+ 92,713	+14.88
Total	170,115,974	162,236,181	−7,879,793	− 4.63

[a] Includes pottery products which could not be separately classified without disclosing individual figures.

Of the States and Territories represented by the 48 totals 36 showed decreases as compared with 1910, and 12 showed increases. The largest actual decrease was sustained by Pennsylvania, $1,824,252, and the largest proportionate loss was by the combined States Idaho and Nevada, 42.87 per cent. The largest increase was in Ohio, $1,137,947, and the largest proportional increase was in Wyoming, 53.56 per cent. In 1910, 26 States showed decreases and 22 showed increases. The decreases in 1911 were not confined to any one section of the country. Of the 12 that showed increases in 1911, 1 was in New England, Maine; 1 in the Central Atlantic States, New Jersey; 5 in the Southern States, Alabama, Georgia, Mississippi, North Carolina, and West Virginia; 1 in the Middle West, Ohio; 2 in the Rocky Mountain region, New Mexico and Wyoming; and 2 on the Pacific coast, California and Oregon. Of the first 10 States in value of products, 4 showed increases in 1911, Ohio, New Jersey, California, and West Virginia.

Value of the products of clay in the United States in 1910 and 1911, with increase or decrease.

Product.	1910	1911	Increase (+) or decrease (−) in 1911.	Percentage of increase (+) or decrease (−) in 1911.
Common brick	$55,219,551	$49,885,262	−$5,334,289	− 9.66
Vitrified paving brick or block	11,004,666	11,115,742	+ 111,076	+ 1.01
Front brick	8,590,057	8,648,877	+ 58,820	+ .68
Fancy or ornamental brick	179,505	177,015	− 2,490	− 1.39
Enameled brick	832,225	1,038,865	+ 206,640	+24.83
Drain tile	10,389,822	8,826,314	− 1,563,508	−15.05
Sewer pipe	11,428,696	11,454,616	+ 25,920	+ .23
Architectural terra cotta	6,976,771	6,017,801	− 958,970	−13.75
Fireproofing	5,110,597	5,660,172	+ 549,575	+10.75
Tile (not drain)	5,240,644	5,356,184	+ 115,540	+ 2.20
Stove lining	503,806	614,116	+ 110,310	+21.90
Fire brick	18,111,474	16,074,686	− 2,036,788	−11.25
Miscellaneous	2,743,482	2,847,971	+ 104,489	+ 3.81
Total brick and tile	136,331,296	127,717,621	− 8,613,675	− 6.32
Total pottery	33,784,678	34,518,560	+ 733,882	+ 2.17
Grand total	170,115,974	162,236,181	− 7,879,793	− 4.63

This table shows that five of the brick and tile products sustained decreases in 1911—the same number as in 1910—and eight showed increases. In general, the decreases in these products were large and the increases were small, so that the total decrease was considerable. Three of the most important products, common brick, drain tile, and fire brick, showed large decreases.

The greatest of all clay products, in point of value and geographic distribution, common brick, showed, as in 1910, the largest decrease, $5,334,289, or 9.66 per cent. This product in 1910 showed a decrease of $2,031,564, or 3.55 per cent.

Vitrified paving brick, which showed a decrease in 1910 of $264,920, or 2.35 per cent, showed an increase in 1911 of $111,076, or 1.01 per cent.

Drain tile showed a decrease of $1,563,508, or 15.05 per cent—the largest proportional decrease of any clay product. In 1910 this product showed an increase of $590,664, or 6.03 per cent.

Front brick and sewer pipe just about held their own, these products increasing $58,830, or 0.68 per cent, and $25,920, or 0.23 per cent, respectively.

Fire brick, next to common brick, showed the largest actual decrease in value, $2,036,788. This was a decrease of 11.25 per cent from 1910. For 1911 silica brick were reported to the value of

$2,520,816, which should be deducted from the figures here given to arrive at the value of clay fire brick.

Architectural terra cotta, next to drain tile, showed the largest proportional decrease, 13.75 per cent.

The total increase among the brick and tile products was $1,282,370; total decrease, $9,896,045—a net decrease of $8,613,675, or 6.32 per cent. The pottery industry showed an increase of $733,882, or 2.17 per cent, making the total net decrease $7,879,793, or 4.63 per cent. In 1910 the brick and tile products increased in value $1,059,524, or 0.78 per cent, and pottery $2,735,237, or 8.81 per cent, a total increase of $3,794,761, or 2.28 per cent.

The following table shows the value of the products of clay in the United States from 1902 to 1911, inclusive, by varieties of product, together with the total for each year, and the number of operating firms reporting.

Products of clay in the United States, 1902–1911, by varieties.

Year.	Number of operating firms reporting.	Common brick.			Vitrified paving brick.		
		Quantity (thousands).	Value.	Average value per thousand.	Quantity (thousands).	Value.	Average value per thousand.
1902	6,046	8,475,067	$48,885,869	$5.77	617,192	$5,744,530	$9.31
1903	6,034	8,463,683	50,532,075	5.97	654,499	6,453,849	9.86
1904	6,108	8,665,171	51,768,558	5.97	735,489	7,557,425	10.28
1905	5,925	9,817,355	61,394,383	6.25	665,879	6,703,710	10.07
1906	5,857	10,027,039	61,300,696	6.11	751,974	7,857,768	10.45
1907	5,536	9,795,698	58,785,461	6.00	876,245	9,654,282	11.02
1908	5,328	7,811,046	44,765,614	5.73	978,122	10,657,475	10.90
1909	5,068	9,791,870	57,251,115	5.85	1,023,654	11,269,586	11.01
1910	4,915	9,221,517	55,219,551	5.99	968,000	11,004,666	11.37
1911	4,628	8,475,277	49,885,262	5.89	948,758	11,115,742	11.72

Year.	Front brick.			Fancy or ornamental brick (value).	Enameled brick (value).	Fire brick (value).	Stove lining (value).	Drain tile (value).
	Quantity (thousands).	Value.	Average value per thousand.					
1902	458,391	$5,318,008	$11.60	$335,290	$471,163	$11,970,511	$630,924	$3,506,787
1903	433,016	5,402,861	12.48	328,387	569,689	[a] 14,062,369	([a])	4,639,214
1904	434,351	5,560,131	12.80	300,233	545,397	11,167,972	([a])	5,348,555
1905	541,590	7,108,092	13.12	293,907	636,279	12,735,404	645,432	5,850,210
1906	617,469	7,895,323	12.79	207,119	773,104	14,206,868	743,414	6,543,289
1907	585,943	7,329,360	12.51	361,243	918,173	14,946,045	627,647	6,864,162
1908	584,482	6,935,600	11.87	259,556	660,862	10,696,216	529,976	8,661,476
1909	816,164	9,712,219	11.90	174,073	993,902	16,620,695	423,583	9,799,158
1910	697,857	8,590,057	12.31	179,505	832,225	18,111,474	503,806	10,389,822
1911	724,911	8,648,877	11.93	177,015	1,038,865	16,074,686	614,116	8,826,314

Year.	Sewer pipe (value).	Architectural terra cotta (value).	Fireproofing (value).	Tile, not drain (value).	Miscellaneous (value).	Total brick and tile (value).	Pottery (value).	Total value.
1902	$7,174,892	$3,526,906	$3,175,593	$3,622,863	$3,678,742	$98,042,078	$24,127,453	$122,169,53
1903	8,525,369	4,672,028	3,861,343	3,505,329	3,073,856	105,626,369	25,436,052	131,062,42
1904	9,187,423	4,107,473	3,629,101	3,023,428	3,669,282	105,864,978	25,158,270	131,023,24
1905	10,097,089	5,003,158	4,098,793	3,647,726	3,564,111	121,778,294	27,918,894	149,697,18
1906	11,114,967	5,739,460	4,586,538	4,634,898	3,988,394	129,591,838	31,440,884	161,032,72
1907	11,482,845	6,026,977	4,250,618	4,551,881	3,000,201	128,798,895	30,143,474	158,942,36
1908	11,003,731	4,577,367	3,168,037	3,877,780	2,268,517	108,062,207	25,135,555	133,197,76
1909	10,322,324	6,251,625	4,466,708	5,291,963	2,694,821	135,271,772	31,049,441	166,321,21
1910	11,428,696	6,976,771	5,110,597	5,240,644	2,743,482	136,331,296	33,784,678	170,115,97
1911	11,454,616	6,017,801	5,660,172	5,356,184	2,847,971	127,717,621	34,518,560	162,236,18

[a] Stove lining is included in fire brick in 1903; in miscellaneous in 1904.

This table shows the growth of the clay-working industries during 0 years. The total value of these products ranged from $122,169,531 n 1902 to $170,115,974 in 1910. For 1911 there was a decrease rom 1910 of $7,879,793, or 4.63 per cent, and the increase of 1911 ver 1902 was $40,066,650, or 32.80 per cent. In four years, 1904, 907, 1908, and 1911, there have been decreases. That of 1904 was o small, $39,173, as to be negligible. The greatest decrease was in 908—$25,744,607, or 16.20 per cent, and the greatest increase was n 1909—$33,123,451, or 24.87 per cent. The maximum value was eached in 1911 in but three brick and tile products, enameled brick, ireproofing, and tile, not drain; pottery also reached its maximum alue in 1911.

The maximum quantity of common brick was reached in 1906 and he maximum value in 1905. The output in 1911 was 1,551,762,000 rick, or 15.48 per cent less than the maximum output, and the alue was $11,509,121, or 18.75 per cent less than the maximum alue. The average price per thousand ranged from $5.73 in 1908 o $6.25 in 1905. The average price in 1911 was $5.89, or 10 cents ower than in 1910.

Vitrified brick reached its maximum quantity and value in 1909 fter increasing steadily from 1905, but it decreased in quantity in 910 and 1911. The output in 1911 was 74,896,000 brick, or 7.32 er cent, less than that of 1909 and 19,242,000, or 1.99 per cent less han that of 1910. The value in 1911 showed a small gain over 1910. The average price per thousand ranged from $9.31 in 1902 to $11.72 n 1911.

Front brick reached its maximum quantity and value in 1909, and showed a decrease in 1910 of 118,307,000 brick, or 14.50 per cent, and an increase in 1911 of 27,054,000 brick, or 3.88 per cent. The average price per thousand ranged from $11.60 in 1902 to $13.12 in 1905, with $11.93, a decrease of 38 cents, in 1911.

Enameled brick reached its maximum value in 1911—$1,038,865. This brick is used only in the highest class of buildings and its use is increasing where a reflecting and sanitary surface is needed. Its value in 1911 was more than twice as great as it was in 1902.

Fire brick showed a considerable decrease in 1911, but its value in that year was exceeded only by two other years, 1909 and 1910.

Draintile, after showing a steady increase for 10 years, nearly trebling its value, showed a large decrease in 1911, and fell back to less than its value of 1909.

Sewer pipe showed a small increase in 1911, but did not reach its maximum value, which was attained in 1907.

Architectural terra cotta, for the third time in 10 years, showed a decrease in value, falling below its value for 1907.

Fireproofing showed a larger increase in value than any other clay product in 1911—$549,575—and reached the maximum value, $5,660,172. This product has increased in value $2,492,135, or 78.66 per cent, since 1908.

Tile, not drain, which embraces all kinds of tile except draintile, has varied more or less It showed a large increase in 1909, a small decrease in 1910, and in 1911 reached its maximum value, $5,356,184.

The number of operating firms reporting showed a decrease from 4,915 in 1910 to 4,628 in 1911 This decrease is no more than was to be expected when the condition of the industries is considered. It is the largest decrease within the decade except in 1907. It should be borne in mind, however, that no attempt is made to show the number of yards or plants, or even the number of owners, but merely the number of operators reporting sales of products during the year, and the number of plants from which no sales were made in 1911 was large. The number of plants is considerably larger than of firms reporting business during the year, as many operators have more than one plant, and some as many as 25.

RANK OF STATES.

The following table shows the rank of States in the value of clay products, the number of operating firms reporting, and the percentage of the total value produced by each State:

Rank of States, value of output, and percentage of total value of clay products in 1910 and 1911.

State or Territory.	1910				1911			
	Rank.	Number of operating firms reporting.	Value.	Percentage of total product.	Rank.	Number of operating firms reporting.	Value.	Percentage of total product.
Ohio	1	683	$31,525,948	18.53	1	633	$32,663,895	20.13
Pennsylvania	2	451	22,094,285	12.99	2	423	20,270,033	12.49
New Jersey	3	167	17,834,309	10.48	3	162	18,178,228	11.21
Illinois	4	346	15,176,161	8.92	4	330	14,333,011	8.83
New York	5	240	11,871,949	6.98	5	222	10,184,376	6.28
Indiana	6	249	8,100,010	4.76	6	302	7,000,771	4.32
Missouri	7	150	7,087,766	4.17	7	122	6,274,353	3.87
California	9	107	4,842,391	2.85	8	92	4,915,866	3.03
Iowa	8	232	5,328,241	3.13	9	214	4,432,874	2.73
West Virginia	10	56	3,998,045	2.35	10	55	4,333,420	2.67
Washington	11	65	3,023,854	1.78	11	55	2,840,372	1.75
Texas	12	124	2,863,930	1.68	12	118	2,659,919	1.64
Georgia	15	109	2,532,038	1.49	13	109	2,636,380	1.63
Kentucky	14	95	2,567,537	1.51	14	96	2,368,094	1.46
Kansas	13	59	2,661,527	1.57	15	53	2,360,262	1.46
Michigan	16	118	2,196,222	1.29	16	111	2,083,932	1.28
Alabama	22	87	1,667,559	.98	17	82	1,947,102	1.20
Maryland	19	55	1,848,273	1.09	18	56	1,772,434	1.09
Virginia	20	84	1,839,687	1.08	19	77	1,739,900	1.07
Massachusetts	21	71	1,707,413	1.00	20	68	1,700,287	1.05
Minnesota	18	84	1,901,296	1.12	21	81	1,693,478	1.04
Colorado	17	77	2,033,714	1.20	22	80	1,606,709	.99
Tennessee	24	97	1,414,288	.83	23	84	1,385,100	.85
North Carolina	25	184	1,223,664	.72	24	163	1,280,126	.79
Connecticut and Rhode Island	23	42	1,568,486	.92	25	42	1,257,339	.78
Wisconsin	26	112	1,176,883	.69	26	101	1,158,139	.71
Oregon	29	66	876,632	.52	27	63	1,081,025	.67
Nebraska	27	78	938,827	.55	28	68	795,894	.49
Oklahoma	28	46	920,921	.54	29	40	756,639	.47
Mississippi	32	71	632,999	.37	30	63	687,836	.42
South Carolina	31	49	704,590	.41	31	44	669,794	.41
Maine	33	55	599,881	.35	32	52	619,214	.38
Utah	30	37	864,258	.51	33	37	548,955	.34
Louisiana	36	54	546,873	.32	34	50	531,949	.33
Arkansas	34	48	578,455	.34	35	50	480,643	.30
New Hampshire	35	29	566,121	.33	36	26	430,748	.27
Montana	37	26	411,824	.24	37	25	260,547	.16
District of Columbia	39	8	242,861	.14	38	9	227,520	.14
Florida	40	23	237,268	.14	39	21	217,535	.13
North Dakota	41	16	227,455	.13	40	11	210,616	.13
Delaware	42	22	216,555	.13	41	21	200,610	.12
Idaho and Nevada	38	49	347,437	.20	42	36	198,479	.12
New Mexico	43	16	129,275	.08	43	15	174,651	.11
Arizona	44	19	126,777	.08	44	20	106,882	.07
Vermont	45	7	89,253	.05	45	7	86,466	.05
Wyoming	47	14	50,237	.03	46	13	77,146	.05
South Dakota	46	11	71,200	.04	47	8	61,365	.04
Porto Rico	48	27	27,773	.02	48	18	19,528	.01
Other States	......	....	[a]623,026	.37	......	....	[a]715,739	.44
Total	......	4,915	170,115,974	100.00	......	4,628	162,236,181	100.00

[a] Undistributed pottery products.

The value of clay products ranged by States in 1911 from $19,528, or 0.01 per cent of the total in Porto Rico, to $32,663,895, or 20.13 per per cent in Ohio. In 1910 Ohio reported 18.53 per cent of the total. Ohio has been the leading clay-working State in the Union since figures were first compiled (1894) by the Survey, and bids fair to remain the leader for years to come, since Ohio's clay products are steadily gaining while those of the second State, Pennsylvania, declined considerably in 1911. The value of Ohio's output in 1911 was $12,393,862, or 61.14 per cent, greater than that of Pennsylvania, the second State in both years, whose output was valued at $20,270,033, or 12.49 per cent of the total. In 1910 Pennsylvania reported 12.99 per cent of the total value. New Jersey was the third State in both years, reporting 10.48 per cent of the total in 1910 and 11.21 per cent in 1911. There was no change in the relative rank of the first seven States. California, which was ninth in 1910, was eighth in 1911, exchanging place with Iowa. There were but slight changes in relative ranks of the other States. The more important States showing the greatest changes were: Alabama rose from twenty-second place to seventeenth; Minnesota fell from eighteenth to twenty-first; Colorado from seventeenth to twenty-second. The first 10 States reported for 1911 wares valued at $122,586,827, or 75.56 per cent of the total; for 1910 the same States reported wares valued at $127,859,105, or 75.16 per cent of the total. The first five States reported wares in 1911 valued at $95,629,543, or 58.94 per cent of the total, as compared with $98,502,652, or 57.90 per cent of the total, in 1910.

BRICK AND TILE.

PRODUCTION.

PRODUCTION BY STATES.

The tables following show the output and value of the building brick and other structural products of clay, and of the fire brick, paving brick, and other clay products used in engineering work, the rank of the State in these products, and the percentage of the total value of each State in 1910 and 1911.

Brick and tile products in the United States in 1910.

Rank.	State or Territory.	Common brick.			Vitrified brick or block.		
		Quantity.	Value.	Average price per thousand.	Quantity.	Value.	Average price per thousand.
		Thousands.			*Thousands.*		
19	Alabama	135,785	$746,961	$5.50	19,772	$236,516	$11.96
44	Arizona	12,740	115,977	9.10			
35	Arkansas	67,583	466,707	6.91	(a)	(a)	10.71
9	California	280,265	1,694,312	6.05	8,538	140,130	16.41
16	Colorado	128,711	852,986	6.63	(a)	(a)	14.15
21	Connecticut and Rhode Island	240,234	1,454,471	6.05	(a)	(a)	14.62
42	Delaware	21,940	174,139	7.94			
39	District of Columbia	28,494	202,136	7.09			
40	Florida	42,195	234,524	5.56			
13	Georgia	305,025	1,620,174	5.31	(a)	(a)	11.11
38	Idaho and Nevada	39,271	322,862	8.22	(a)	(a)	25.00
3	Illinois	1,196,526	6,896,836	5.76	115,903	1,415,355	12.21
6	Indiana	234,297	1,402,154	5.98	61,034	682,888	11.19
8	Iowa	149,914	1,088,266	7.26	19,887	239,283	12.03
12	Kansas	218,353	922,940	4.22	118,950	1,089,978	9.16
14	Kentucky	115,890	743,732	6.42	(a)	(a)	12.74
36	Louisiana	80,555	502,330	6.24			
33	Maine	54,641	367,903	6.73	(a)	(a)	25.02
20	Maryland	164,795	1,051,381	6.38	(a)	(a)	16.96
22	Massachusetts	165,315	1,120,924	6.78			
15	Michigan	232,551	1,363,316	5.86	9,080	116,446	12.82
17	Minnesota	182,895	1,104,898	6.04			
32	Mississippi	91,065	527,981	5.80			
7	Missouri	201,281	1,284,997	6.38	56,703	647,441	11.42
37	Montana	26,124	254,282	9.73	(a)	(a)	20.00
27	Nebraska	119,017	791,351	6.65	(a)	(a)	8.88
34	New Hampshire	77,567	566,121	7.30			
5	New Jersey	401,103	2,215,628	5.52			
43	New Mexico	7,929	63,703	8.03	(a)	(a)	12.0
4	New York	1,380,084	6,897,438	5.00	21,662	334,432	15.4
24	North Carolina	167,966	1,039,319	6.19			
41	North Dakota	17,941	140,862	7.85			
2	Ohio	409,773	2,507,742	6.12	289,817	2,876,157	9.9
28	Oklahoma	131,146	763,236	5.82	11,959	114,315	9.5
29	Oregon	58,588	482,333	8.23			
1	Pennsylvania	828,703	5,371,707	6.48	101,330	1,204,724	11.8
48	Porto Rico	2,915	25,109	8.61			
31	South Carolina	115,128	657,801	5.71			
46	South Dakota	6,050	57,150	9.45			
25	Tennessee	140,878	826,533	5.87	(a)	(a)	10.8
11	Texas	271,640	1,779,062	6.55	(a)	(a)	13.6
30	Utah	54,537	411,415	7.54	(a)	(a)	24.1
45	Vermont	9,633	58,766	6.10			
18	Virginia	229,982	1,460,460	6.35			
10	Washington	130,634	956,510	7.32	(a)	(a)	18.8
23	West Virginia	77,916	508,422	6.53	46,098	564,578	12.2
26	Wisconsin	161,083	1,071,457	6.65			
47	Wyoming	4,859	50,237	10.34			
	Other States [b]				87,267	1,342,423	15.3
	Total	9,221,517	55,219,551	5.99	968,000	11,004,666	11.3
	Per cent of brick and tile products		40.51			8.07	
	Per cent of total of clay products		32.46			6.47	

[a] Included in "Other States."

[b] Includes all products made by less than 3 producers in 1 State.

Brick and tile products in the United States in 1910—Continued.

Rank.	State or Territory.	Front brick.			Fancy or ornamental brick.	Drain-tile.	Sewer pipe.	Architectural terra cotta.	Fire-proofing.
		Quantity.	Value.	Average price per thousand.	Value.	Value.	Value.	Value.	Value.
		Thousands.							
19	Alabama	(a)	(a)	$15.96	....	$3,773	(a)	....	(a)
44	Arizona	(a)	(a)	20.00	....	....	....	....	....
35	Arkansas	(a)	(a)	11.02	....	4,258	....	....	....
9	California	11,475	$285,468	24.88	$48,572	55,386	$1,031,061	$678,249	$151,503
16	Colorado	30,334	368,538	12.15	(a)	18,066	(a)	....	32,565
21	Connecticut and Rhode Island	(a)	(a)	15.75	(a)	....	....	....	....
42	Delaware	(a)	(a)	19.49	(a)	(a)	....	....	....
39	District of Columbia	....	....	......	....	(a)	(a)	....	....
40	Florida	....	....	......	....	(a)	....	....	....
13	Georgia	13,649	129,393	9.48	(a)	8,920	373,387	(a)	19,354
38	Idaho and Nevada	675	13,850	20.52	....	(a)	....	....	....
3	Illinois	22,138	274,699	12.41	10,875	1,613,698	538,633	1,680,438	552,905
6	Indiana	46,691	478,627	10.25	(a)	2,071,564	406,543	(a)	466,877
8	Iowa	8,142	103,276	12.68	....	3,337,851	313,430	....	200,965
12	Kansas	25,814	223,875	8.67	(a)	50,726	(a)	(a)	(a)
14	Kentucky	10,238	99,532	9.72	(a)	66,217	(a)	....	(a)
36	Louisiana	(a)	(a)	10.55	....	(a)	....	....	....
33	Maine	(a)	(a)	10.76	....	(a)	(a)	....	....
20	Maryland	260	3,953	15.20	(a)	5,899	....	(a)	....
22	Massachusetts	(a)	(a)	15.44	....	....	....	....	(a)
15	Michigan	2,209	27,533	12.46	....	348,205	(a)	....	....
17	Minnesota	7,240	88,000	12.15	....	160,706	(a)	....	93,731
32	Mississippi	1,431	15,963	11.16	....	68,065	....	....	....
7	Missouri	38,428	516,505	13.44	23,673	121,068	1,210,348	(a)	146,931
37	Montana	344	6,146	17.87	....	(a)	(a)	....	(a)
27	Nebraska	(a)	(a)	16.00	....	(a)	....	....	(a)
34	New Hampshire	....	....	......	....	....	....	....	....
5	New Jersey	47,451	609,845	12.85	(a)	23,147	(a)	2,000,039	1,582,101
43	New Mexico	2,749	32,977	12.00	....	....	....	....	(a)
4	New York	9,229	137,748	14.93	(a)	272,836	136,576	1,108,371	210,954
24	North Carolina	550	5,800	10.55	....	9,555	(a)	....	(a)
41	North Dakota	4,642	77,808	16.76	....	....	....	....	....
2	Ohio	134,759	1,489,094	11.05	32,995	1,869,823	3,289,537	....	934,960
28	Oklahoma	2,682	35,288	13.16	....	....	....	....	....
29	Oregon	5,580	137,040	24.56	....	51,516	(a)	....	(a)
1	Pennsylvania	171,415	2,001,967	11.68	35,768	11,480	583,418	472,150	300,187
48	Porto Rico	....	....	......	(a)	....	....	....	(a)
31	South Carolina	(a)	(a)	14.20	....	(a)	....	....	....
46	South Dakota	(a)	(a)	11.20	(a)	....	....	....	....
25	Tennessee	10,119	98,450	9.73	(a)	29,707	(a)	....	(a)
11	Texas	21,646	325,074	15.02	....	18,408	(a)	....	(a)
30	Utah	19,220	250,263	13.02	....	7,758	(a)	....	(a)
45	Vermont	....	....	......	....	(a)	....	....	....
18	Virginia	20,813	294,348	14.14	(a)	5,276	(a)	....	....
10	Washington	5,570	124,952	22.43	....	34,128	817,086	198,358	114,501
23	West Virginia	(a)	(a)	10.00	....	2,330	(a)	....	(a)
26	Wisconsin	2,400	29,900	12.46	(a)	64,391	....	....	....
47	Wyoming	....	....	......	....	....	....	....	....
	Other States [b]	19,964	304,145	15.23	27,622	55,065	2,728,677	839,166	303,063
	Total	697,857	8,590,057	12.31	[c]1,011,730	10,389,822	11,428,696	6,976,771	5,110,597
	Per cent of brick and tile product	....	6.30	......	.74	7.62	8.38	5.12	3.75
	Per cent of total of clay products	....	5.05	......	.60	6.11	6.72	4.10	3.01

[a] Included in "Other States."

[b] Includes all products made by less than 3 producers in 1 State.

[c] Includes enameled brick, valued at $832,225, made in the following States: California, Illinois, Maryland, Missouri, New Jersey, and Pennsylvania.

Brick and tile products in the United States in 1910—Continued.

Rank.	State or Territory.	Tile, not drain.	Stove lining.	Fire brick.			Miscellaneous.[a]	Total value.	Percentage of total value.
		Value.	Value.	Quantity.	Value.	Average price per thousand.	Value.		
				Thousands.					
19	Alabama			10,365	$163,672	$15.79	$22,269	$1,645,313	1.21
44	Arizona							126,777	.09
35	Arkansas			(b)	(b)	12.42		550,105	.40
9	California	$97,685	(b)	15,416	371,017	24.07	90,754	4,744,968	3.48
16	Colorado	(b)		9,280	205,550	22.15	95,639	1,982,827	1.45
21	Connecticut and Rhode Island		(b)	(b)	(b)	22.00		1,568,486	1.15
42	Delaware							216,555	.16
39	District of Columbia							242,861	.18
40	Florida			(b)	(b)	15.00		237,268	.17
13	Georgia	51,800		3,482	67,622	19.42	10,490	2,510,740	1.84
38	Idaho and Nevada			(b)	(b)	21.82		347,437	.26
3	Illinois	(b)		20,179	368,730	18.27	44,730	14,331,414	10.51
6	Indiana	622,726	(b)	10,182	166,217	16.32	540,151	7,143,306	5.24
8	Iowa			(b)	(b)	18.00	27,185	5,310,706	3.90
12	Kansas	(b)					81,046	2,661,527	1.95
14	Kentucky	318,966		56,041	955,557	17.05	2,000	2,418,116	1.77
36	Louisiana						27,479	546,873	.40
33	Maine			(b)	(b)	25.00		599,881	.44
20	Maryland		$23,067	15,559	296,541	19.06		1,614,348	1.18
22	Massachusetts	(b)	166,018	1,999	71,780	35.91		1,469,018	1.08
15	Michigan	(b)	(b)				(b)	2,083,525	1.53
17	Minnesota			(b)	(b)	15.11		1,901,296	1.39
32	Mississippi						(b)	613,009	.45
7	Missouri	(b)	(b)	91,444	2,059,845	22.53	214,447	7,058,705	5.18
37	Montana	(b)		2,121	43,671	20.59		411,824	.30
27	Nebraska						(b)	938,827	.69
34	New Hampshire							506,121	.42
5	New Jersey	1,199,113	(b)	42,394	1,001,063	23.61	294,135	9,245,854	6.78
43	New Mexico	(b)		533	12,183	22.86		129,275	.10
4	New York	72,815	86,248	14,190	514,990	36.29	5,160	9,778,288	7.17
24	North Carolina						1,000	1,208,674	.89
41	North Dakota			(b)	(b)	30.19		227,455	.17
2	Ohio	1,896,572	(b)	116,784	1,709,039	14.63	587,909	17,231,236	12.64
28	Oklahoma						8,082	920,921	.68
29	Oregon	(b)		(b)	(b)	30.00		876,632	.64
1	Pennsylvania	413,047	132,567	346,423	6,454,928	18.63	563,563	19,814,355	14.53
48	Porto Rico	(b)						27,773	.02
31	South Carolina			(b)	(b)	13.96		696,600	.51
46	South Dakota							71,200	.05
25	Tennessee			1,287	14,907	11.58		1,205,108	.88
11	Texas			5,751	75,950	13.21	31,037	2,744,845	2.01
30	Utah			(b)	(b)	30.12	3,756	864,258	.63
45	Vermont		(b)					89,253	.07
18	Virginia			(b)	(b)	14.48		1,793,270	1.32
10	Washington			672	25,017	37.23	25,318	3,023,854	2.22
23	West Virginia	104,633		2,184	32,003	14.65		1,322,457	.97
26	Wisconsin						2,000	1,167,918	.86
47	Wyoming							50,237	.04
	Other States[c]	463,287	95,906	10,144	212,164	20.92	65,332	(d)	
	Total	5,240,644	503,806	[e]922,209	[e]18,111,474	19.09	2,743,482	136,331,296	100.00
	Per cent of brick and tile products	3.85	.37		13.28		2.01	100.00	
	Per cent of total of clay products	3.08	.30		10.64		1.61	80.15	

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[a] Including adobes, aquarium ornaments, burnt-clay ballast, charcoal furnaces, chimney pipe and tops, conduits, crucibles, curbing, flue lining, gas logs, glasshouse supplies, glazed brick, grave markers, muffles, radial chimney brick, retorts, saggers, scorifiers, stone pumps, vases and ornaments, and wall coping.

[b] Included in "Other States."

[c] Includes all products made by less than 3 producers in 1 State.

[d] The total of "Other States" is distributed among the States to which it belongs in order that they may be fully represented in the totals.

[e] In the total quantity and total value of fire brick are included, respectively, 145,779,000 silica brick valued at $3,289,028, of which 112,033,000, valued at $2,231,063, was produced, by Pennsylvania, and the remainder, 33,746,000, valued at $1,057,965, by Alabama, Colorado, Georgia, Illinois, Indiana, Missouri and Montana.

Brick and tile products in the United States in 1911.

Rank.	State or Territory.	Common brick.			Vitrified brick or block.		
		Quantity.	Value.	Average price per thousand.	Quantity.	Value.	Average price per thousand.
		Thousands.			*Thousands.*		
16	Alabama	129,694	$708,903	$5.47	21,444	$246,707	$11.50
44	Arizona	10,249	90,282	8.81			
35	Arkansas	57,398	389,091	6.78	(a)	(a)	8.14
8	California	282,199	1,716,442	6.08	9,186	155,885	16.97
19	Colorado	89,950	559,519	6.22	2,334	31,572	13.53
24	Connecticut and Rhode Island	206,631	1,153,409	5.58	(a)	(a)	15.50
41	Delaware	20,158	165,225	8.20			
38	District of Columbia	25,225	187,690	7.44			
39	Florida	36,207	216.365	5.98			
11	Georgia	325,948	1,692,610	5.19	(a)	(a)	12.22
42	Idaho and Nevada	22,251	189,804	8.53			
3	Illinois	1,074,486	6,126,911	5.70	124,623	1,627,683	13.06
7	Indiana	192,057	1,132,555	5.90	31,198	392,136	12.57
9	Iowa	154,434	1,025,011	6.64	8,879	103,384	11.64
13	Kansas	183.809	694,586	3.78	83,337	823,505	9.88
14	Kentucky	107,771	692,378	6.42	(a)	(a)	12.37
34	Louisiana	83,007	487,322	5.87			
32	Maine	51,444	364.414	7.08	(a)	(a)	24.74
20	Maryland	160,229	999,791	6.24	(a)	(a)	16.98
21	Massachusetts	166,834	1,079,778	6.47	(a)	(a)	11.00
15	Michigan	252,465	1,301,998	5.16	5,597	78,336	14.00
18	Minnesota	153,015	868,037	5.67	(a)	(a)	13.16
30	Mississippi	92,431	584,960	6.33			
6	Missouri	217,466	1,309,164	6.02	44,813	488,299	10.90
37	Montana	16,023	155,715	9.72			
28	Nebraska	102,706	657,001	6.40	(a)	(a)	11.55
36	New Hampshire	57,567	430,748	7.48			
4	New Jersey	429,367	2,401,962	5.59	(a)	(a)	14.99
43	New Mexico	12,416	101,034	8.14	(a)	(a)	11.35
5	New York	1,143,726	5,918,286	5.17	17,035	290,728	17.07
23	North Carolina	178,235	1,076,183	6.04			
40	North Dakota	15,288	108,691	7.11			
2	Ohio	389,515	2,299,194	5.90	315,944	3,200,475	10.13
29	Oklahoma	102,013	528,287	5.18	19,535	201,100	10.29
27	Oregon	66,267	533,652	8.05			
1	Pennsylvania	774,122	4,963,232	6.41	124,125	1,511,061	12.17
48	Porto Rico	1,656	15,278	9.23	(a)	(a)	15.00
31	South Carolina	103,788	624,103	6.01			
47	South Dakota	5,621	42,297	7.52			
25	Tennessee	144,824	842,864	5.82	(a)	(a)	10.41
12	Texas	255,811	1,596.763	6.24	(a)	(a)	15.92
33	Utah	34,407	267,938	7.79	(a)	(a)	10.00
45	Vermont	9,561	55,702	5.83			
17	Virginia	219,035	1,374,439	6.27			
10	Washington	99,588	695,100	6.98	40,291	743,352	18.45
22	West Virginia	59,961	400,916	6.69	56,956	681,747	11.97
26	Wisconsin	151,331	985,824	6.51			
46	Wyoming	7,091	73,808	10.41			12.42
	Other States[b]				43,461	539,772	
	Total	8,475,277	49,885,262	5.89	948,758	11,115,742	11.72
	Per cent of brick and tile products		39.06			8.70	
	Per cent of total of clay products		30.75			6.85	

[a] Included in "Other States."

[b] Includes all products made by less than 3 producers in 1 State.

Brick and tile products in the United States in 1911—Continued.

Rank.	State or Territory.	Front brick.			Fancy or ornamental brick.	Drain tile.	Sewer pipe.	Architectural terra cotta.	Fireproofing.
		Quantity.	Value.	Average price per thousand.	Value.	Value.	Value.	Value.	Value.
		Thousands.							
16	Alabama	9,169	$128,403	$14.00	(a)	$3,777	(a)	....	(a)
44	Arizona	(a)	(a)	19.63	....	....	....	....	....
35	Arkansas	738	8,030	10.88	....	4,261	....	....	(a)
8	California	15,197	381,226	25.09	(a)	34,780	$999,546	$475,647	$200,923
19	Colorado	26,189	294,783	11.26	$1,220	23,655	297,800	....	(a)
24	Connecticut and Rhode Island	(a)	(a)	12.49	(a)	....	....	....	....
41	Delaware	(a)	(a)	19.80	....	(a)	....	....	....
38	District of Columbia	....	....	....	....	(a)	(a)	....	(a)
39	Florida	....	....	....	....	(a)	....	....	....
11	Georgia	12,788	112,675	8.81	....	5,000	417,267	(a)	(a)
42	Idaho and Nevada	390	7,925	20.32	....	....	....	....	....
3	Illinois	19,786	240,135	12.14	10,281	1,372,049	507,694	1,879,275	552,994
7	Indiana	40,777	480,709	11.79	(a)	2,006,803	455,014	(a)	437,778
9	Iowa	9,241	114,178	12.36	(a)	2,468,962	284,817	....	374,628
13	Kansas	27,887	213,711	7.66	(a)	35,875	(a)	(a)	15,257
14	Kentucky	8,972	90,330	10.07	....	64,005	(a)	....	(a)
34	Louisiana	(a)	(a)	9.53	....	(a)	....	....	....
32	Maine	3,139	31,602	10.07	....	(a)	(a)	....	....
20	Maryland	757	10,574	13.97	(a)	8,048	....	(a)	....
21	Massachusetts	(a)	(a)	18.00	....	....	....	....	(a)
15	Michigan	2,498	31,572	12.64	....	313,072	(a)	....	(a)
18	Minnesota	10,853	135,085	12.45	....	121,965	(a)	....	109,812
30	Mississippi	1,012	11,020	10.89	....	65,196	....	....	....
6	Missouri	25,491	330,332	12.96	24,269	164,393	1,156,626	402,969	123,499
37	Montana	819	15,234	18.60	....	(a)	(a)	....	(a)
28	Nebraska	(a)	(a)	20.00	....	14,339	....	....	(a)
36	New Hampshire	....	....	....	....	....	....	....	....
4	New Jersey	47,606	528,656	11.10	(a)	26,502	103,137	1,669,973	1,728,811
43	New Mexico	753	11,380	15.11	....	(a)	....	....	(a)
5	New York	9,942	133,563	13.43	(a)	112,609	116,184	673,529	227,871
23	North Carolina	(a)	(a)	9.81	....	11,704	(a)	....	(a)
40	North Dakota	(a)	(a)	17.28	(a)	....	....	....	....
2	Ohio	159,118	1,630,898	10.25	25,340	1,684,420	3,445,601	....	1,086,287
29	Oklahoma	2,551	24,703	9.68	....	....	....	....	....
27	Oregon	(a)	(a)	26.43	....	69,857	(a)	....	(a)
1	Pennsylvania	184,569	2,111,492	11.44	44,883	12,779	560,809	389,000	300,687
48	Porto Rico	....	....	....	....	(a)	(a)	....	(a)
31	South Carolina	900	10,400	11.55	....	(a)	....	....	....
47	South Dakota	(a)	(a)	10.94	(a)	(a)	....	....	(a)
25	Tennessee	9,547	94,733	9.92	(a)	51,721	(a)	....	(a)
12	Texas	19,331	297,847	15.41	....	12,817	(a)	....	47,03
33	Utah	11,978	160,057	13.36	....	17,596	(a)	....	(a)
45	Vermont	....	....	....	....	(a)	....	....	....
17	Virginia	21,032	314,201	14.94	(a)	10,875	(a)	....	....
10	Washington	5,224	118,615	22.71	(a)	29,314	738,473	283,608	153,18
22	West Virginia	(a)	(a)	14.98	....	3,487	(a)	....	(a)
26	Wisconsin	9,920	100,140	10.09	....	58,547	....	....	(a)
46	Wyoming	(a)	(a)	15.04	....	....	....	....	....
	Other States[b]	26,737	474,668	17.75	71,022	17,906	2,371,648	243,800	301,40
	Total	724,911	8,648,877	11.93	[c]1,215,880	8,826,314	11,454,616	6,017,801	5,660,17
	Per cent of brick and tile products	....	6.77	....	.95	6.91	8.97	4.71	4.4
	Per cent of total of clay products	....	5.33	....	.75	5.44	7.06	3.71	3.4

[a] Included in "Other States."

[b] Includes all products made by less than 3 producers in 1 State.

[c] Includes enameled brick, valued at $1,038,865, made in the following States: California, Illinois, Maryland, Missouri, New Jersey, and Pennsylvania.

Brick and tile products in the United States in 1911—Continued.

Rank.	State or Territory.	Tile, not drain.	Stove lining.	Fire brick.			Miscellaneous.[a]	Total value.	Percentage of total value.
		Value.	Value.	Quantity.	Value.	Average price per thousand.	Value.		
				Thousands.					
16	Alabama	....	....	11,929	$193,375	$16.21	$16,221	$1,918,606	1.50
44	Arizona	....	....	(b)	(b)	60.00	....	106,882	.08
35	Arkansas	....	....	(b)	(b)	12.76	....	465,143	.36
8	California	$90,632	(b)	17,323	468,120	27.02	104,185	4,757,530	3.72
19	Colorado	(b)	....	8,057	182,766	22.68	65,096	1,566,636	1.23
24	Connecticut and Rhode Island	(b)	(b)	(b)	(b)	22.00	....	1,257,339	.98
41	Delaware	....	....	....	....	....	....	200,610	.16
38	District of Columbia	....	....	....	....	....	....	227,520	.18
39	Florida	....	....	....	....	....	....	217,535	.17
11	Georgia	(b)	(b)	5,694	86,000	15.10	....	2,612,050	2.05
42	Idaho and Nevada	....	....	(b)	(b)	37.50	....	198,479	.16
3	Illinois	(b)	....	19,285	286,039	14.83	48,272	13,353,200	10.46
7	Indiana	(b)	(b)	2,903	76,116	26.22	491,994	5,996,034	4.69
9	Iowa	(b)	....	....	....	....	7,814	4,390,555	3.44
13	Kansas	(b)	....	(b)	(b)	20.10	197,667	2,360,262	1.85
14	Kentucky	292,563	....	52,074	890,810	17.11	....	2,254,000	1.76
34	Louisiana	....	....	....	....	....	27,599	531,949	.42
32	Maine	....	....	(b)	(b)	20.00	....	619,214	.48
20	Maryland	(b)	$28,469	13,161	249,674	18.97	....	1,518,023	1.19
21	Massachusetts	(b)	167,802	1,955	70,104	35.86	....	1,471,761	1.15
15	Michigan	(b)	(b)	(b)	(b)	18.08	(b)	1,953,442	1.53
18	Minnesota	(b)	....	(b)	(b)	21.13	....	1,693,478	1.33
30	Mississippi	....	....	....	....	....	3,000	664,176	.52
6	Missouri	(b)	(b)	86,945	1,763,548	20.28	169,517	6,269,145	4.91
37	Montana	....	....	840	31,659	37.69	....	260,547	.20
28	Nebraska	....	....	....	....	....	23,465	795,894	.62
36	New Hampshire	....	....	....	....	....	....	430,748	.34
4	New Jersey	1,197,330	(b)	58,470	1,344,884	23.00	331,276	9,776,287	7.65
43	New Mexico	....	....	1,041	25,654	24.64	....	174,651	.14
5	New York	86,602	82,803	8,453	347,415	41.10	14,837	8,006,012	6.27
23	North Carolina	....	....	(b)	(b)	13.85	2,300	1,271,570	1.00
40	North Dakota	....	....	(b)	(b)	24.37	....	210,616	.16
2	Ohio	2,312,482	86,673	93,511	1,539,450	16.46	577,810	17,888,630	14.01
29	Oklahoma	....	....	....	....	....	2,549	756,639	.59
27	Oregon	....	....	(b)	(b)	26.15	485	1,081,025	.85
1	Pennsylvania	358,913	164,848	294,062	5,555,529	18.89	606,908	18,113,216	14.18
48	Porto Rico	(b)	(b)	....	....	....	....	19,528	.02
31	South Carolina	....	....	(b)	(b)	14.47	....	663,674	.52
47	South Dakota	(b)	....	....	....	....	....	61,365	.05
25	Tennessee	....	....	1,365	15,915	11.66	700	1,187,961	.93
12	Texas	....	....	4,918	78,230	15.91	49,636	2,527,502	1.98
33	Utah	....	....	(b)	(b)	37.99	5,066	548,955	.43
45	Vermont	....	(b)	....	....	....	....	86,466	.07
17	Virginia	....	....	(b)	(b)	15.15	....	1,726,491	1.35
10	Washington	....	(b)	2,250	63,654	28.29	(b)	2,840,372	2.22
22	West Virginia	136,586	....	10,314	74,596	7.23	45,884	1,453,218	1.14
26	Wisconsin	....	....	....	....	....	2,028	1,149,539	.90
46	Wyoming	....	....	....	....	....	....	77,146	.06
	Other States [c]	881,076	83,521	10,471	210,332	20.09	53,662	(d)	......
	Total	5,356,184	614,116	[e]809,504	[e]16,074,686	19.86	2,847,971	127,717,621	100.00
	Per cent of brick and tile products	4.20	.48	....	12.59	....	2.23	100.00	......
	Per cent of total of clay products	3.30	.38	....	9.91	....	1.76	78.73	......

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[a] Including adobes, burnt-clay ballast, charcoal furnaces, chimney pipe and tops, conduits, crucibles, flue lining, gas logs, glasshouse supplies, grave and lot markers, muffles, radial chimney brick and block, retorts, saggers, scorifiers, semi-enameled brick, silo blocks, vases and ornaments, and wall coping.

[b] Included in "Other States."

[c] Includes all products made by less than 3 producers in 1 State.

[d] The total of "Other States" is distributed among the States to which it belongs in order that they may be fully represented in the totals.

[e] In the total quantity and total value of fire brick are included, respectively, 104,483,000 silica brick, valued at $2,520,816, of which 74,674,000, valued at $1,525,086, was produced by Pennsylvania, and the remainder, 29,809,000, valued at $995,730, by Alabama, Colorado, Illinois, Indiana, Missouri, Montana, and Utah.

Common brick, as its name implies, is the most widely distributed of the clay products, being reported from every State but not from Alaska or Hawaii. There were 8,475,277,000 common brick, valued at $49,885,262, reported in 1911, a decrease of 746,240,000 brick, or 8.09 per cent. In 1910 there was a decrease of 570,353,000 from 1909. The value showed a decrease in 1911 of $5,334,289, or 9.66 per cent. Only 14 States showed increases in quantity of production and 34 showed decreases; 10 showed increase in value and 38 showed decrease. Ten States showed increases in both production and value—California, Georgia, Mississippi, Missouri, New Jersey, New Mexico, North Carolina, Oregon, Tennessee, and Wyoming. Of the great common brick producing States, New York, Illinois, Pennsylvania, New Jersey, and Ohio, only one, New Jersey, showed an increase in production. Four States—Iowa, Louisiana, Massachusetts, and Michigan—showed increases in quantity of brick but decreases in value. New York was the largest producer of common brick in 1911, as in 1910, reporting 1,143,726,000 brick, valued at $5,918,286, or $5.17 per thousand, a decrease in quantity from 1910 of 236,358,000, or 17.13 per cent, and in value of $979,152, or 14.20 per cent. This production was 398,826,000 brick, or 25.85 per cent, less than that of 1909, New York's maximum output. Illinois was the second State in 1911, reporting 1,074,486,000 brick, valued at $6,126,911, or $5.70 per thousand; this was a decrease of 122,040,000 brick in quantity, or 10.20 per cent, and of $769,925, or 11.16 per cent in value. The third State in rank was Pennsylvania, which reported 774,122,000 brick, valued at $4,963,232, or $6.41 per thousand, a decrease of 54,581,000 brick, or 6.59 per cent, and of $408,475, or 7.60 per cent. New Jersey ranked fourth, displacing Ohio and reported 429,367,000 brick, valued at $2,401,962, or $5.59 per thousand. This was an increase of 28,264,000 brick, or 7.05 per cent, and of $186,334, or 8.41 per cent in value. Ohio which was fourth in production of common brick in 1910 was fifth in 1911, reporting 389,515,000 brick, valued at $2,299,194, or $5.90 per thousand, a decrease of 20,258,000 brick, or 4.94 per cent, and of $208,548, or 8.32 per cent. New York was the leading State in the number o common brick marketed, but in the value of this variety of brick Illinois was first, its 1,074,486,000 common brick being valued a $208,625 more than New York's 1,143,726,000 brick. Of New York's product, 865,510,000 brick, or 75.67 per cent, was from the Hudson River region, and the output of Illinois 682,720,000 brick, or 63.5 per cent, was from Cook County. The average price per thousan in 1911 ranged from $3.78 in Kansas to $10.41 in Wyoming, the average for the entire country being $5.89. In 1910 these same State reported the extremes in price of $4.22 and $10.34, respectively. I New York there was an increase of 17 cents per thousand and i Illinois there was a decrease of 6 cents. Common brick compose 39.06 per cent of the value of all brick and tile products and 30.7 per cent of all clay products in 1911.

Vitrified paving brick was reported from 30 States, a gain of 2 ove 1910, Idaho and Montana reporting none, and Massachusetts, Minnesota, New Jersey, and Porto Rico appearing as producers of thi variety of brick. Ohio was the leading State in 1911, as in 191 reporting 315,944,000 brick, valued at $3,200,475, or $10.13 pe thousand. This was an increase of 26,127,000 brick, or 9.01 per cent, in quantity and of $324,318, or 11.28 per cent, in value. Ohio reported 33.41 per cent of the total quantity and 28.79 per cent of the total value in 1911. Illinois was second, reporting an increase over 1910 of 8,720,000 brick in quantity, or 7.52 per cent, and of $212,328, or 15 per cent, in value. Pennsylvania was third and Kansas fourth. The average price per thousand ranged in the important producing States from $9.88 in Kansas to $18.45 in Washington.

Pennsylvania was the leading front brick producing State in 1911 as in 1910, reporting 25.46 per cent of the total quantity and 24.41 per cent of the total value. Ohio was second in both quantity and value, and New Jersey third. These relative ranks were the same as those of 1910. Next to common brick, front brick is the most widely distributed of clay products, being reported from 43 States in 1911, an addition of 1—Wyoming—to the list for 1910.

Drain tile was reported from 40 States and Territories in 1911, the only ones not reporting being Arizona, Connecticut, Rhode Island, Idaho, Nevada, Massachusetts, New Hampshire, North Dakota, Oklahoma, and Wyoming. Iowa, Indiana, Ohio, Illinois, and Michigan were the leading States in the order named. These five States together reported drain tile valued at $7,845,306, or 88.89 per cent of the total in 1911; in 1910 these States reported drain tile valued at $9,241,141, or 88.94 per cent of the total. In 1911 Iowa showed a decrease of $868,889; Indiana, $64,761; Ohio, $185,403; Illinois, $241,649; and Michigan, $35,133. Twelve States showed increases, most of them very small ones, the largest being from Missouri, $43,325.

Sewer pipe was reported from 28 States and Territories in 1911, a gain of 1—Porto Rico. Ohio was the leading State and reported a product valued at $3,445,601, or 30.08 per cent of the total. Missouri was second, California third, and Washington fourth. These realtive ranks were the same as in 1910.

Architectural terra cotta was reported from 11 States in 1911, the same as in 1910. In only 7 States were there a sufficient number of producers to permit the publication of figures without disclosing individual returns. Illinois was the leading State in 1911, reporting 31.23 per cent of the total, and New Jersey was second. In 1910 Illinois was second and New Jersey was first. New York was third in both years. In 1911 Illinois showed an increase of $198,837 and New Jersey showed a decrease of $330,066. New York also showed a large decrease.

Fireproofing, including hollow building tile or block, was reported from 30 States and 2 Territories, an increase of 5 over 1910—Arkansas, District of Columbia, Michigan, South Dakota, and Wisconsin. New Jersey continues to be the leading State, reporting 30.54 per cent of the total. Ohio was second and Illinois third.

"Tile, not drain," includes roofing, floor, wall, and art tile. These wares were reported from 21 States and Territories—2 more than in 1910—Rhode Island, Iowa, Maryland, Minnesota, and South Dakota reporting wares under this head, Montana, New Mexico, and Oregon dropping out. Ohio was the leading producer, reporting 43.17 per cent of the total. New Jersey was second and Pennsylvania third.

Fire brick in 1911, as in 1910 and 1909, was second only to common brick in value. It was reported from 34 States in 1911, an increase of 2 over 1910. Arizona, Kansas, Michigan, and North Carolina appeared as producers and Florida and Iowa dropped out. The quantity reported, including silica brick, decreased from 922,209,000 9-inch equivalent brick in 1910 to 809,504,000 in 1911, a decrease of 112,705,000, or 12.22 per cent. The total value was $16,074,686 in 1911 as compared with $18,111,474 in 1910, a decrease of $2,036,788, or 11.25 per cent. Pennsylvania continues to be the leading producer, reporting 41.71 per cent of the quantity of clay fire brick and 40.99 per cent of its value. This was a decrease of 52,361,000 brick, or 15.11 per cent, and of $899,399, or 13.93 per cent, from 1910. Ohio was second in quantity but third in value; Missouri was third in quantity and second in value; New Jersey was fourth in quantity and value, and Kentucky was fifth in quantity and value. The average price per thousand ranged in the important States from $7.23 in West Virginia to $41.10 in New York, with a general average of $19.22. Fire brick constituted 12.59 per cent of the value of all brick and tile products and 9.91 per cent of all clay products in 1911.

Pennsylvania was again the leading State in the value of brick and tile products, reporting wares valued at $18,113,216, or 14.18 per cent of the total, a decrease from 1910 of $1,701,139, or 8.59 per cent. Ohio was second, with 14.01 per cent of the total; this was an increase over 1910 of $657,394, or 3.82 per cent. Illinois continued to be third, reporting 10.46 per cent of the total, and a decrease from 1910 of $978,214, or 6.83 per cent. New Jersey, which was fifth in 1910, was fourth in 1911; New York was fifth in 1911; Missouri was seventh in 1910 and sixth in 1911; Indiana was seventh, California eighth, Iowa ninth, and Washington tenth.

HUDSON RIVER REGION.

The Hudson River region is one of the most interesting brickmaking regions of the United States, and possibly of the world. The territory extends along both sides of Hudson River from New York City to Cohoes and embraces 10 counties, 9 in New York and 1 in New Jersey. This region is interesting not only from the geologi occurrence of the immense deposits of clay, but from the fact that i is, on account of its geographic location and easy accessibility, the principal source of a cheap supply of common building brick for New York City and vicinity—the largest market for building material in the New World.

History.—The region has been the scene of brickmaking activit for nearly a century.[1] Prior to 1810 efforts to establish the industr were made, with more or less success, attempts having been made, i is said, even before the Revolution. Such brick as were made prio to 1810 were for local consumption and it was not until that year tha a kiln was burned for a regular market. This was done by a Philadelphia concern, but the enterprise failed and the work was abandoned. In 1817 James Wood, an Englishman, who had learned h trade in his native land, was attracted to Haverstraw by the vas quantity of brick clay and the then unlimited supply of wood fo fuel, leased a piece of land on the river shore, and started the firs successful brickyard in Rockland County.

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[1] Green, F. B., History of Rockland County.

When Wood opened his yard in Haverstraw the process of making brick was the same as that pursued from the earliest times. To Wood is generally given the credit of discovering in 1828 the use of coal dust as an ingredient in the manufacture of brick. It seems that this process had been used in England, but was little known. A long and bitter litigation ensued to test the validity of Wood's patent. An English friend sent him a small quantity of anthracite coal which was then being developed in Pennsylvania. On burning it he found that it gave an intense heat with little smoke. The idea came to him that coal could be used to burn brick. A piece of coal was pulverized and mixed with the clay for four bricks. The burning of these bricks showed that the experiment was a success. It remained however, to learn the proper proportion of clay and coal dust. Wood obtained a load of anthracite coal and had it ground in a neighboring grist mill. He mixed this coal with the clay in nearly equal proportions, but the kilns burned to slag and was ruined. Further tests were made and at last the proper proportions were ascertained. It was found that bricks containing coal dust burned in the upper layers of the kiln as well as in the lower layers and that a more uniform burn throughout the kiln could be obtained by this process.

Wood is also said to have invented a machine consisting of a wooden axle with spokes projecting from it, which, revolving on a central shaft, mixed the clay, sand, and coal dust more rapidly than had been done before. This machine was probably the forerunner of the ring-pit tempering wheel of to-day. Another improvement which Wood was the means of introducing was a mold with a bottom and a vent. Up to that time molds without bottoms had been used. These molds, when filled, required great care in handling. The time saved by Wood's discoveries and improvements was from 7 to 10 days to a kiln.

The next yard established after Wood's was that of the Allison family, north of the foot of the present main street in Haverstraw, and in a short time several yards were opened at Grassy Point and below Caldwell's Landing. By 1834 these yards were in a precarious financial condition. In November of that year, however, David Munn took hold of the brick business with a determination to make it pay and succeeded. In 1838 there were six yards in operation with an annual production of 12,000,000 brick. In the following years the industry advanced rapidly, largely through the efforts of Munn. In 1852 a fresh impetus was given to the brick industry by the invention of an automatic brick machine by Richard A. Ver Valen. Hall's improved machine had been in use for some time, but was operated by hand, and, besides, the brick were so soft as to require great care in handling. Ver Valen's machine not only tempered the clay, but molded the brick so stiff that they retained their shape. This machine was the cause of litigation that was decided in Ver Valen's favor.

The first recorded brickmaker's strike in this region was in 1853, when hundreds of strikers marched from yard to yard, uttering threats of violence. The strike was caused by a reduction in wages. It was attended with so much violence that troops had to be called out to suppress it. In 1877 another strike occurred. At this time the operators sent to Canada for laborers. When the French Canadians thus engaged began work, violence was resorted to by the strikers, and the troops were again called out.

Notwithstanding the enormous quantities of brick made in this region at the present time, the method of manufacture followed is practically the same as that pursued in the early history of th industry. The brick are made by the soft-mud process, which appears to be the only successful one in this region. The clay i hauled from the pit to the tempering pit by horse and cart, is tempered in ring pits where coal and sand are mixed with the clay, an after molding are spread upon the ground to dry. Some of thes yards have the rack and pallet system of drying, but the general practice is to dry in the open air. After drying, the brick are set under shed and burnt in the simplest of all kilns, the "scove," which consists merely of the brick properly set surrounded by a wall of unburne brick daubed over with mud to prevent the escape of the heat. Afte burning and cooling, the brick are carried in wheelbarrows to barge and shipped to New York. Probably the greatest change in the bric industry along the Hudson in recent years is in the method of shipment. For many years the brick schooners were picturesque sight on the Hudson, but they have given way to the steam-drawn barg which holds many times more brick than the old schooner.

Attempts have been made to use these clays for other varieties clay products with, however, little success, so that common brick the only product now made of these terrace clays along the river.

Production.—The following table shows the production and valu of brick along Hudson River from 1901 to 1911, with the number firms reporting and the average price received per thousand:

Production of common brick in the Hudson River district from 1901 to 1911, inclusiv

Year.	Number of operating firms reporting.	Quantity.	Value.	Avera price p thousand
		Thousands.		
1901	127	830,154	$3,880,215	$4
1902	127	833,065	3,683,379	4
1903	115	844,500	3,973,316	4
1904	119	987,644	5,810,114	5
1905	129	1,297,389	9,063,753	6
1906	135	1,274,372	7,672,639	6
1907	132	1,064,892	5,515,585	5
1908	123	875,979	4,107,382	4
1909	127	1,313,760	6,438,642	4
1910	135	1,142,284	5,544,600	4
1911	125	926,072	4,717,633	5
Total	....	11,390,111	60,407,258	5

This table shows that the number of brick marketed in this regi in 1911 was 926,072,000, valued at $4,717,633, or $5.09 per thousan as compared with 1,142,284,000 brick in 1910, valued at $5,544,60 This was a decrease of 216,212,000 brick, or 18.93 per cent, in qua tity, and of $826,967, or 14.91 per cent, in value. In both quanti and value this was the lowest year since 1903, except 1908.

The year 1909 was the one of maximum quantity and 1905 was t year of maximum value. Compared with these years 1911 showe decrease of 387,688,000 brick, or 29.51 per cent, and of $4,346,120, 47.95 per cent. The value of the product of 1911 was, however, b $1,721,009, or 26.73 per cent, less than that of 1909, and the quanti but 371,317,000 brick, or 28.62 per cent less than that of 1905.

The number of brick reported from this region in the 11 years cov-ed by the table was the enormous total of 11,390,111,000. These ick, if laid flat, would be sufficient for a walk 20 feet wide around e world and would form a cube 750 feet on each edge. No accurate formation is at hand concerning the production for previous years, ut it is probable that the total up to 1900, inclusive, was three times great as the total for the 11 years given in the table, so that this gion has furnished about 45,000,000,000 building brick for New York ty and vicinity and at extremely low prices.

It has been estimated[1] that the clay in the New York portion of is region will be capable of furnishing 1,200,000,000 brick a year ntil about 1960.

The average price per thousand for the region in 1911 was $5.09, s compared with $4.85 in 1910 and with $4.90 in 1909. The maxi-um average price was $6.99 in 1905 and the minimum was $4.42 in 902, with an average for the whole period of $5.30. The number f operating firms reporting has varied from 115 in 1903 to 135 in 906 and 1910. As in other branches of the clay-working industries, e number of active firms reporting is not equivalent to the number f yards, as many firms have more than one yard. The decrease in e firms in the New York portion of the region amounted to 10 in 911.

The following table shows the production of common brick in the udson River district in 1910 and 1911, by counties:

roduction of common brick in the Hudson River district from Cohoes to New York City in 1910 and 1911, by counties.

County.	1910				1911			
	Number of firms reporting.	Common brick.		Average price per thousand.	Number of firms reporting.	Common brick.		Average price per thousand.
		Quantity.	Value.			Quantity.	Value.	
		Thousands.				*Thousands.*		
lbany	14	72,699	$374,094	$5.15	12	60,223	$331,847	$5.51
olumbia	7	83,881	418,355	4.99	7	59,158	293,561	4.96
utchess	18	135,747	640,353	4.72	17	133,890	695,913	5.20
reene	6	29,498	124,623	4.22	5	30,282	160,641	5.30
range	9	160,228	771,831	4.82	8	113.305	517,575	4.57
ensselaer	9	18,301	94,915	5.19	6	16,334	90,022	5.51
ockland	29	244,628	1,164,480	4.76	28	178,184	940,351	5.28
lster	24	273,770	1,303,127	4.76	24	213,779	1,049,063	4.91
estchester	9	64,932	335,415	5.17	8	60,355	298,563	4.95
Total for New York portion of district	125	1,083,684	5,227,193	4.82	115	865,510	4,377,536	5.06
ergen County, N. J.	10	58,600	317,407	5.42	10	60,562	340,097	5.62
Grand total	135	1,142,284	5,544,600	4.85	125	926,072	4,717,633	5.09

New York's portion was 93.46 per cent of the quantity of brick nd 92.79 per cent of the value of the output of the region. This ortion, consisting of 865,510,000 brick in 1911, showed a decrease of 18,174,000 brick, or 20.13 per cent, from 1910. It constituted 75.67 er cent of New York's output of common brick in 1911, as compared with 78.52 per cent in 1910. The value of New York's portion of the region in 1911 was $4,377,536, a decrease of $849,657, or 16.25 per cent, from 1910, and $1,682,495, or 27.76 per cent, from 1909. The value of the common brick of New York's portion of this region was 42.98 per cent of all of New York's clay products and 54.68 per cent of its brick and tile products.

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[1] Clemens, C. J., Trans. Am. Inst. Min. Eng., vol. 29, 1899, p. 83.

Of the counties included in this region in 1911 Ulster, as for several years, was first in output and value, reporting 213,779,000 brick, valued at $1,049,063, a decrease of 59,991,000 brick and of $254,064 from 1910. Rockland was second with 178,184,000 brick, valued at $940,351, a decrease of 66,444,000 brick and of $224,129. Dutchess County was third in 1911, displacing Orange County, and reporting 133,890,000 brick, valued at $695,913, a decrease of 1,857,000 brick and an increase of $55,560. The only county in the New York portion of the region showing an increase in both quantity and value of output was Greene. The highest average price per thousand in 1911 was $5.51, attained in Albany and Rensselaer counties; the lowest was 4.57 in Orange County. In 1910 the highest average price was $5.19, attained in Rensselaer County, and the lowest was $4.22 in Greene County.

New Jersey's portion of the production of this region is small, being but 60,562,000 brick in 1911, or only 6.54 per cent of the output, and $340,097, or 7.21 per cent of the value. This was an increase of 1,962,000 brick, or 3.35 per cent, and of $22,690, or 7.15 per cent over 1910. The average price per thousand increased from $5.42 in 1910 to $5.62 in 1911. This was 53 cents higher than the average for the whole region, 56 cents higher than that for New York's portion of the region, and 11 cents higher than the highest county average in New York.

POTTERY.

INTRODUCTION.

The following tables show the status of the pottery industry in 1910 and 1911 and the production, imports, and exports of pottery since 1901, inclusive. The figures indicate that the industry has more than held its own and has showed some progress even in a year of only moderate prosperity. This condition should be highly gratifying to the industry, especially when it is considered that not only did the domestic industry advance but imports showed a larger proportionate decline.

The year 1911 showed the greatest value for domestic pottery yet recorded. This increase in value, however, came from the lower grades of ware and china, sanitary ware and porcelain electrical supplies. The most important variety in value, white ware, showed a slight decrease, 2.81 per cent. The volume of business done was possibly even larger than the value would indicate, as the general complaint, at least among the white-ware potters, has been that prices have been low and the margin of profit small.

The value of all domestic pottery marketed in 1911 was $34,518,560, an increase of $733,882, or 2.17 per cent. On the other hand, imports, which are almost exclusively of the higher grades of ware, decreased $492,542, or 4.42 per cent. The continued advancement in quality of ware and the growing tendency to the use of American-made wares will no doubt insure a steady growth of this industry. With the almost constant growth of domestic production and the decrease in imports—the value of production in 1911 being $3\frac{1}{4}$ times that of imports as against less than $2\frac{1}{2}$ times in 1901—the prospects for the pottery industry in the United States are bright.

The number of operating firms reporting continues to decrease. This decrease does not necessarily mean that the number of plants decreased, as no efforts are made to ascertain the number of plants. In the manufacture of the higher grade wares some new companies were organized—one or two consolidations took place, and some of the smaller firms went out of business. The most interesting and important development in the geographic extension of the industry was the apparently earnest effort to establish a pottery for the manufacture of white ware in the South close to the principal source of supply of raw material.

PRODUCTION.

The following table shows the statistics of the pottery production of the United States from 1901 to 1911:

Value of pottery products in the United States, 1901–1911, by varieties.

Year.	Number of operating firms reporting.	Red earthenware.	Stoneware and yellow and Rockingham ware.	White ware, including C. C. ware, etc.	China, bone china, delft, and belleek ware.	Sanitary ware.	Porcelain electrical supplies.	Miscellaneous.	Total.
1901......	535	$703,698	$2,855,638	$11,608,898	$1,392,864	$2,877,650	$1,141,362	$1,883,750	$22,463,860
1902......	518	735,386	3,383,678	12,371,111	1,219,293	3,555,662	1,350,255	1,512,068	24,127,453
1903......	546	698,175	3,658,836	12,493,012	1,757,502	3,362,263	1,464,980	2,001,284	25,436,052
1904......	556	756,625	3,701,844	11,924,404	1,512,115	3,585,375	1,431,452	2,246,455	25,158,270
1905......	533	780,637	3,969,016	12,809,414	1,558,730	4,580,145	2,253,061	1,967,891	27,918,894
1906......	540	909,262	4,193,884	14,152,503	1,787,776	5,098,310	2,838,284	2,460,865	31,440,884
1907......	509	845,465	4,280,601	13,913,680	1,930,669	4,863,222	2,613,771	1,696,066	30,143,474
1908......	497	757,900	3,518,841	11,474,147	1,581,020	4,373,590	2,009,005	1,421,052	25,135,555
1909......	466	805,906	3,993,859	13,728,316	[a]1,766,766	5,989,295	3,047,499	[a]1,717,800	31,049,441
1910......	463	854,196	3,796,688	14,780,980	1,962,126	6,758,996	3,794,153	1,837,539	33,784,678
1911......	449	893,678	4,120,608	14,366,251	2,057,985	7,031,458	4,232,101	1,816,479	34,518,560

[a] China, bone china, delft, and belleek ware for Ohio is included in miscellaneous.

This table shows that the value of the pottery products of the United States in 1911 was $34,518,560. This is the largest value yet reported and exceeded that of 1910 by $733,882, or 2.17 per cent, and that of 1906 by $3,077,676, or 9.79 per cent. Only one product decreased in value in 1911, white ware, which declined $414,729, or 2.81 per cent. Three products, china, sanitary ware, and porcelain electrical supplies, reached their maximum value in 1911, the products showing the largest increase being porcelain electrical supplies, which increased $437,948, or 11.54 per cent.

The value of white ware, including china, but exclusive of sanitary ware and porcelain electrical supplies, was $16,424,236, as compared with $16,743,106 in 1910, a decrease of $318,870, or 1.90 per cent. These articles constituted 47.58 per cent of all pottery products in 1911, and 49.56 per cent in 1910. If the value of sanitary ware and porcelain electrical supplies be added, the value for 1911 would be $27,687,795, or 80.21 per cent of all pottery products, an increase over the figures for 1910 of $391,540, or 1.43 per cent, and an increase of $3,155,919 over 1909.

China ware showed an increase of $95,859, or 4.89 per cent. The value of china ware reported for 1911 was the highest ever recorded, and the prospects are that larger quantities of this ware will be produced in the future.

Sanitary ware, which consists of lavatories, bathtubs, and other sanitary appliances, increased in value $272,462, or 4.03 per cent.

In the following tables will be found the statistics of the production of pottery in the United States in 1910 and 1911, by States and varieties of product, the former year being given for comparison:

Value of pottery products in 1910 by varieties of products, by States.

Rank of State.	State.	Number of active firms reporting.	Red earthenware.	Stoneware and yellow and Rockingham ware.	White ware, including C. C. ware, white granite, semiporcelain ware, and semivitreous porcelain ware.	China, bone china, delft, and belleek ware.
19	Alabama	16	$3,475	$16,371		
18	Arkansas	4	(a)	26,150		
14	California	11	34,367	42,726		
15	Colorado	4	(a)	(a)		
	Connecticut		(a)	(a)		
	District of Columbia		(a)			
20	Georgia	21	10,558	10,740		
7	Illinois	22	25,658	708,958		
6	Indiana	14	12,650	89,423	(a)	
22	Iowa	5	6,290	(a)		
	Kansas		(a)			
11	Kentucky	8	10,004	139,417		
	Louisiana		(a)			
	Maine			(a)		
9	Maryland	9	9,171		(a)	
8	Massachusetts	13	148,909	9,654	(a)	
13	Michigan	6	90,450			
	Minnesota		(a)	(a)		
21	Mississippi	6	(a)	19,027		
17	Missouri	8	3,080	25,981		
	Montana		(a)			
	New Hampshire					
2	New Jersey	58	26,529	55,734	$1,345,156	$1,131,41
	New Mexico					
5	New York	22	26,863	43,325	(a)	642,59
23	North Carolina	22	1,961	13,029		
1	Ohio	113	161,799	1,664,572	9,730,408	
	Oregon		(a)	(a)		
4	Pennsylvania	33	178,348	323,990	(a)	188,1
	Porto Rico		(a)	(a)		
25	South Carolina	4	5,540	(a)		
10	Tennessee	9	4,540	44,640		
12	Texas	13	6,481	112,604		
	Utah		(a)	(a)		
16	Virginia	3				
	Washington		(a)	(a)		
3	West Virginia	14		(a)	1,894,429	
24	Wisconsin	3	8,965			
	Other States[b]		78,558	450,347	1,810,987	
	Total	[c]463	854,196	3,796,688	14,780,980	1,962,1
	Per cent of pottery products		2.53	11.24	43.75	5.
	Per cent of total clay products		.50	2.23	8.69	1.
	Number of firms reporting each variety		159	180	63	

[a] Included in "Other States."
[b] Includes all products made by less than 3 producers in 1 State.
[c] Includes 22 firms not distributed.

Value of pottery products in 1910 by varieties of products, by States—Continued.

Rank of State.	State.	Sanitary ware.	Porcelain electrical supplies.	Miscellaneous.[a]	Total value.	Percentage of total.
19	Alabama			$2,400	$22,246	0.07
18	Arkansas			2,000	28,350	.08
14	California	(b)		(b)	97,423	.29
15	Colorado			8,387	50,887	.15
	Connecticut		(b)	(b)	(c)	
	District of Columbia				(c)	
20	Georgia				21,298	.06
7	Illinois	(b)		(b)	844,747	2.50
6	Indiana	$468,301	(b)		956,704	2.83
22	Iowa			(b)	17,535	.05
	Kansas				(c)	
11	Kentucky				149,421	.44
	Louisiana			(b)	(c)	
	Maine				(c)	
9	Maryland	(b)		4,000	233,925	.69
8	Massachusetts		(b)	22,423	238,395	.71
13	Michigan		(b)	(b)	112,697	.33
	Minnesota				(c)	
21	Mississippi				19.990	.06
17	Missouri				29,001	.09
	Montana				(c)	
	New Hampshire			(b)	(c)	
2	New Jersey	4,955,066	$874,013	200,545	8,588,455	25.42
	New Mexico			(b)	(c)	
5	New York	(b)	957,101	67,687	2,093,661	6.20
23	North Carolina				14,990	.05
1	Ohio	327,438	1,277,144	1,133,351	14,294,712	42.31
	Oregon				(c)	
4	Pennsylvania	254,747	(b)	14,726	2,279,930	6.75
	Porto Rico			(b)	(c)	
25	South Carolina				7,990	.02
10	Tennessee			(b)	209,180	.62
12	Texas				119,085	.35
	Utah				(c)	
16	Virginia		(b)	(b)	46,417	.14
	Washington				(c)	
3	West Virginia	618,868	(b)	97,343	2,675,588	7.92
24	Wisconsin				8,965	.03
	Other States[d]	134,576	685,895	284,677	[e] 623,026	1.84
	Total	6,758,996	3,794,153	1,837,539	33,784,678	100.00
	Per cent of pottery products	20.00	11.23	5.44	100.00	
	Per cent of total clay products	3.97	2.23	1.08	19.85	
	Number of firms reporting each variety	38	37	73		

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[a] Including art and chemical pottery, craquelle porcelain, faïence, Grueby, Hampshire, Indian, Pewabic, and Teco pottery, Guernsey earthenware, handmade tile, jardinieres, pins, stilts and spurs for potters' use, porcelain door knobs, filter stones and tubes, shuttle eyes and thread guides, porcelain hardware trimmings, porcelain lighting appliances, tobacco pipes, toy marbles, turpentine cups, and vases.

[b] Included in "Other States."

[c] Included in [e] ($623,026).

[d] Includes all products made by less than 3 producers in 1 State.

[e] Made up of State totals of Connecticut, District of Columbia, Kansas, Louisiana, Maine, Minnesota, Montana, New Hampshire, New Mexico, Oregon, Porto Rico, Utah, and Washington.

Value of pottery products in 1911 by varieties of products, by States.

Rank of State.	State.	Number of active firms reporting.	Red earthenware.	Stoneware and yellow or Rockingham ware	White ware, including C. C. ware, white granite, semiporcelain ware, and semivitreous porcelain ware.	China, bone china, delft, and belleek ware.
17	Alabama	18	$11,243	$14,753		
20	Arkansas	5	(a)	11,650		
11	California	9	32,146	48,190		
15	Colorado	4	(a)	(a)		
	Connecticut		(a)	(a)		
	District of Columbia		(a)			
18	Georgia	20	17,530	6,800		
7	Illinois	23	41.875	832,813	(a)	
6	Indiana	14	5,700	81,567	(a)	
16	Iowa	5	6,936	(a)		
	Kansas			(a)		
14	Kentucky	8	12,880	101,214		
	Louisiana					
	Maine			(a)		
8	Maryland	9	8,281	(a)	(a)	
9	Massachusetts	12	150,038	13,541	(a)	
13	Michigan	6	80,580			
	Minnesota		(a)	(a)		
19	Mississippi	7	1,850	21,560		
25	Missouri	6	2,755	2,453		
	Montana		(a)			
	New Hampshire					
2	New Jersey	56	38,910	75,915	$1,148,904	$1,105,278
	New Mexico					
4	New York	22	34,295	40,946	(a)	730,983
23	North Carolina	19	1,333	7,223		
1	Ohio	110	233.060	1,758,785	9,612,315	
	Oregon		(a)	(a)		
5	Pennsylvania	31	159,420	304,998	(a)	216,724
	Porto Rico					
24	South Carolina	4	3,281	2,839		
10	Tennessee	7	3,938	38,759		
12	Texas	14	8,963	123,454		
	Utah		(a)	(a)		
21	Virginia	3				
	Washington		(a)	(a)		
3	West Virginia	13		(a)	1,920,294	(a)
22	Wisconsin	3	8,600			
	Other States[b]		30,064	633,148	1,684,783	5,000
	Total	[c]449	893,678	4,120,608	14,366,251	2,057,985
	Per cent of pottery products		2.59	11.94	41.62	5.96
	Per cent of total clay products		.55	2.54	8.86	1.27
	Number of firms reporting each variety		160	175	61	15

[a] Included in "Other States."
[b] Includes all products made by less than 3 producers in 1 State.
[c] Includes 21 firms not distributed.

Value of pottery products in 1911 by varieties of products, by States—Continued.

Rank of State.	State.	Sanitary ware.	Porcelain electrical supplies.	Miscellaneous.[a]	Total.	Percentage of total.
17	Alabama			$2,500	$28,496	0.08
20	Arkansas			3,500	15,500	.04
11	California	(b)		(b)	158,336	.46
15	Colorado			3,573	40,073	.12
	Connecticut		(b)	(b)	(c)	
	District of Columbia				(c)	
18	Georgia				24,330	.07
7	Illinois	(b)	(b)	9,700	979,811	2.84
6	Indiana	$549,470	(b)		1,004,737	2.91
16	Iowa			(b)	36,319	.11
	Kansas				(c)	
14	Kentucky				114,094	.33
	Louisiana			(b)	(c)	
	Maine				(c)	
8	Maryland	(b)		2,000	254,411	.74
9	Massachusetts		(b)	13,832	228,526	.66
13	Michigan		(b)	(b)	130,490	.38
	Minnesota				(c)	
19	Mississippi			250	23,660	.07
25	Missouri				5,208	.02
	Montana				(c)	
	New Hampshire			(b)	(c)	
2	New Jersey	4,898,588	$913,921	220,425	8,401,941	24.34
	New Mexico			(b)	(c)	
4	New York	(b)	988,716	51,686	2,178,364	6.31
23	North Carolina				8,556	.02
1	Ohio	378,779	1,610,925	1,181,401	14,775,265	42.80
	Oregon				(c)	
5	Pennsylvania	215,590	(b)	11,108	2,156,817	6.25
	Porto Rico			(b)	(c)	
24	South Carolina				6,120	.02
10	Tennessee			(b)	197,139	.57
12	Texas				132,417	.38
	Utah				(c)	
21	Virginia	(b)		(b)	13,409	.04
	Washington				(c)	
3	West Virginia	814,599	(b)	79,173	2,880,202	8.34
22	Wisconsin				8,600	.03
	Other States[d]	174,432	718,539	237,331	[e]715,739	2.07
	Total	7,031,458	4,232,101	1,816,479	34,518,560	100.00
	Per cent of pottery products	20.37	12.26	5.26	100.00	
	Per cent of total clay products		4.33	2.61	1.12	21.28
	Number of firms reporting each variety	26	36	68		

[a] Including art and chemical pottery, craquelle porcelain, faïence, Guernsey earthenware, Hampshire, Indian, Pewabic, and Teco pottery, hand-made tile, jardinieres, pins, stilts, and spurs for potters' use, porcelain door knobs, filter stones and tubes, shuttle eyes and thread guides, porcelain hardware trimmings, porcelain lighting appliances, tobacco pipes, toy marbles, turpentine cups, umbrella stands and vases.

[b] Included in "Other States."

[c] Included in [e] ($715,739).

[d] Includes all products made by less than 3 producers in 1 State.

[e] Made up of State totals of Connecticut, District of Columbia, Kansas, Louisiana, Maine, Minnesota, Montana, New Hampshire, New Mexico, Oregon, Porto Rico, Utah, and Washington.

The number of States reporting for 1911 ware classed as pottery in this report was 38, the same as for 1910. The important producing States, especially in the higher grades of ware, are few. General ware was reported from 9 States, an increase of 1, Illinois reporting for 1911; china from 4, an increase of 1, West Virginia; sanitary ware from 10, an increase of 1, Virginia being added; porcelain electrical supplies from 10, the same number as for 1910.

Red earthenware being made from common variety of clay, is the most widespread branch of the pottery industry, and was reported from 30 States, a decrease of 3—Kansas, Louisiana, and Porto Rico. Ohio was the leading State, displacing Pennsylvania, which was second in 1911. Ohio's product was valued at $233,060, an increase of

$71,261, or 44.04 per cent. Pennsylvania's product declined $18,928, or 10.61 per cent. Massachusetts was third in both 1910 and 1911, reporting ware valued at $150,038 in 1911, an increase of less than 1 per cent. These three leading States reported 60.71 per cent of the total in 1911, as compared with 57.25 per cent in 1910. Red earthenware was reported by 160 producers in 1911, 159 in 1910, and 147 in 1909. In 1911 it constituted 2.59 per cent of the total of pottery products, and in 1910, 2.53 per cent.

Stoneware, including yellow and Rockingham ware, was reported from 29 States in 1911, an increase of 1. Kansas and Maryland reported these wares in 1911, Porto Rico reporting none. Ohio, as for many years, was the leading State, showing an increase in 1911 of $94,213, or 5.66 per cent. Illinois, as in 1910, was second, showing an increase of $123,855, or 17.47 per cent, over 1910. Ohio alone reported 42.68 per cent of the value of this product for 1911, and Illinois 20.21 per cent. The number of producers reporting this item continued to decrease, 175 reporting for 1911, as compared with 180 for 1910, 196 for 1909, and 209 for 1908. Stoneware constituted 11.94 per cent of the value of pottery products in 1911, 11.24 per cent in 1910, and 12.86 per cent in 1909.

As shown by these tables, the pottery products of greatest value are embraced under the heading white ware and represent the general household wares. They were reported from 9 States in 1911, an increase of 1—Illinois again appearing as a producer. Ohio has been the leading producer of these wares for many years, and reported white ware valued at $9,612,315 for 1911, a decrease of $118,093, or 1.21 per cent. Ohio's product in 1911 was 66.91 per cent of the value of the entire product, as against 65.83 per cent in 1910 and 64.71 per cent in 1909. West Virginia was second, as for several years, and reported ware valued at $1,920,294 for 1911, an increase of $25,865, or 1.37 per cent, over 1910. New Jersey was third in both years, reporting ware valued at $1,148,904, a decrease of $196,252, or 14.59 per cent. White ware composed 41.62 per cent of all pottery products in 1911, 43.75 per cent in 1910, and 44.21 per cent in 1909. The number of producers reporting white ware decreased by 2 in 1911.

China was reported from 4 States in 1911, an increase of 1—West Virginia. New Jersey was the leading china-producing State in 1911, as in 1910, and reported ware valued at $1,105,278, a decrease of $26,134, or 2.31 per cent. The output of New Jersey constituted 53.71 per cent of the entire product in 1911. New York was second and Pennsylvania was third. The china output is from a commercial point of view of comparatively little importance; it composed but 5.96 per cent of the value of pottery in 1911 and 5.81 per cent in 1910. The number of potters reporting china in 1911 was 15, an increase of 1.

Ten States reported sanitary ware for 1911, an increase of 1—Virginia. New Jersey continued to be the largest producer, reporting ware valued at $4,898,588, or 69.67 per cent of the total for 1911 This was a decrease of $56,478, or 1.14 per cent. West Virginia was second, reporting wares valued at $814,599, an increase of $195,731 or 31.63 per cent, over 1910. Indiana was third, reporting an increase of $81,169, or 17.33 per cent, over 1910. The number of producers decreased 2 in 1911. Sanitary ware was 20.37 per cent of the value of all pottery products in 1911, and 20 per cent in 1910.

Porcelain electrical supplies were reported from 10 States in 1911, the same number as in 1910, though Illinois appeared as a producer and Virginia reported no porcelain electrical supplies. As in 1910, in only 3 States was there a sufficient number of producers to permit the publication of figures without disclosing individual returns. Ohio was the largest producer, reporting $1,610,925, or 38.06 per cent of the total. This was an increase of $333,781, or 26.13 per cent. The number of firms reporting these wares decreased by 1 in 1911, notwithstanding the large increase in this branch of the industry, which constituted 12.26 per cent of the total value of pottery products in 1911, 11.23 per cent in 1910, and 9.82 per cent in 1909.

Ohio continued to be the leading pottery-producing State of the Union, reporting for 1911 wares valued at $14,775,265, or 42.80 per cent of the total. This was an increase of $480,553, or 3.36 per cent, over 1910, when Ohio reported pottery valued at $14,294,712, or 42.31 per cent of the total. Ohio's principal pottery product is white ware, which constituted 65.06 of its entire product in 1911. New Jersey is the second largest pottery-producing State. For 1911 it reported wares valued at $8,401,941, or 24.34 per cent of the total. This was a decrease of $186,514, or 2.17 per cent. New Jersey's principal pottery product is sanitary ware, which was 58.30 per cent of its total for 1911. West Virginia was third in 1911, reporting ware valued at $2,880,202, or 8.34 per cent of the total, an increase of $204,614, or 7.65 per cent. New York was fourth, displacing Pennsylvania, the former reporting 6.31 per cent of the total and the latter 6.25 per cent, there being a difference of but $21,547 in the value of the pottery reported by these two States. Indiana and Illinois maintained their relative ranks of sixth and seventh with 2.91 per cent and 2.84 per cent of the total, respectively. The first five States, Ohio, New Jersey, West Virginia, New York, and Pennsylvania, reported 88.04 per cent of the total production in 1911; in 1910 these States reported 88.60 per cent, and in 1909 87.69 per cent.

In considering the rank of the States it should be borne in mind that the small number of producers in many of them in 1911, which prevents the publication of State totals without disclosing individual returns, makes the rank of all but the first few the relative and not the actual rank.

CONSUMPTION.

The pottery imported into the United States in 1911 was valued at $10,638,616 and the production at $34,518,560, a total of $45,157,176. After deducting exports, domestic $1,401,366 and foreign $24,566, the net consumption was valued at $43,731,244, of which the domestic production was 78.93 per cent. In 1910 the proportion was 77.08 per cent, in 1909 it was 76.19 per cent, and the next highest was in 1902, when it was 72.91 per cent.

IMPORTS AND EXPORTS.

The following table shows the imports of clay products from 1901 to 1911:

Value of earthenware, china, brick, and tile imported and entered for consumption in the United States, 1901–1911.

Year.	Pottery.				Brick, fire brick, tile, etc.	Grand total.
	Brown earthen and common stone ware.[a]	China and porcelain, not decorated.	China and porcelain, decorated.	Total.		
1901	$51,551	$1,094,078	$8,385,514	$9,531,143	$150,268	$9,681,411
1902	58,926	1,016,010	8,495,598	9,570,534	235,737	9,806,271
1903	95,890	1,234,223	9,897,588	11,227,701	228,589	11,456,290
1904	81,951	1,329,146	9,859,144	11,270,241	218,170	11,488,411
1905	100,618	1,157,573	10,717,871	11,976,062	172,079	12,148,141
1906	96,400	1,312,326	11,822,376	13,231,102	175,797	13,406,899
1907	113,477	1,315,591	12,156,544	13,585,612	225,320	13,810,932
1908	70,629	1,142,444	9,309,718	10,522,791	162,341	10,685,132
1909	98,716	1,245,479	9,263,017	10,607,212	189,536	10,796,748
1910	154,614	1,293,986	9,682,558	11,131,158	222,183	11,353,341
1911	164,871	1,221,756	9,251,989	10,638,616	166,133	10,804,749

[a] Including Rockingham ware.

The imports of all clay products in 1911 decreased $548,592, or 4.83 per cent; in 1910 there was an increase over 1909 of 5.16 per cent. Of these imports 98.40 per cent was pottery and 1.54 per cent brick and tile. Of the pottery imports 98.45 per cent was general ware and 1.55 per cent was of the lower grades. The pottery imports decreased $492,542, or 4.42 per cent, in 1911, and the brick imports $56,050, or 25.23 per cent.

Value of exports of clay wares of domestic manufacture from the United States, 1905–1911.

Year.	Brick.			Pottery.			Grand total.
	Fire.	All other.	Total.	Earthen and stone ware.	China.	Total.	
1905	$536,002	[a]$263,876	$799,878	$882,069	$101,485	$983,554	$1,783,432
1906	637,441	[a] 247,625	885,066	1,003,969	114,481	1,118,450	2,003,516
1907	631,779	[a] 185,192	816,971	1,022,730	108,911	1,131,641	1,948,612
1908	[b] 550,243	113,243	663,486	906,266	77,494	983,760	1,647,246
1909	[b] 1,002,270	147,622	1,149,892	776,842	86,853	863,695	2,013,587
1910	[c] 634,775	968,138	1,602,913	928,475	113,214	1,041,689	2,644,602
1911	1,057,725	1,206,629	2,264,354	1,278,892	122,474	1,401,366	3,665,720

[a] Building brick only.
[b] Includes all brick other than building brick.
[c] Figures cover period from July 1 to Dec. 31.

The exports of domestic clay products were valued at $3,665,720, an increase of $1,021,118, or 38.61 per cent, in 1911; in 1910 they increased $631,015, or 31.34 per cent. Of these exports 38.23 per cent was brick and 61.77 per cent pottery. Brick and tile exports gained $661,441, or 41.26 per cent, in 1911; pottery exports increased $359,677, or 34.53 per cent, and of these, china constituted 8.74 per cent and the lower grades 91.26 per cent.

CLAY PRODUCTS IN SEVERAL STATES.

The following table gives the statistics of clay products from 1907 to 1911, inclusive, for some of the more important clay-working States, and will be of interest to those who desire to compare the growth of the industries in these States for several years. Owing to the changes in the classification of the products in some of the minor items, the figures do not always represent solely the value of the products named, though the classification as given in the tables is the nearest that can be made without reconstructing them entirely. The item "Miscellaneous" under each State includes all products not otherwise classified and those that could not be published separately without disclosing individual returns.

Clay products of the United States, by States, from 1907 to 1911.

ALABAMA.

Product.	1907	1908	1909	1910	1911
Brick:					
Common—					
Quantity	159,315,000	120,237,000	146,180,000	135,785,000	129,694,000
Value	$1,004,644	$690,963	$799,693	$746,961	$708,903
Average per M	$6.31	$5.75	$5.47	$5.50	$5.47
Vitrified—					
Quantity	13,362,000	18,248,000	20,444,000	19,772,000	21,444,000
Value	$183,895	$244,084	$262,376	$236,516	$246,707
Average per M	$13.76	$13.38	$12.83	$11.96	$11.50
Front—					
Quantity	(a)	(a)	(a)	(a)	9,169,000
Value	(a)	(a)	(a)	(a)	$128,403
Average per M	$13.90	$17.89	$16.19	$15.96	$14.00
Fancy value	(a)	(a)	(a)	....	(a)
Fire do	$170,711	$122,354	$196,887	$163,672	$193,375
Draintile do	(a)	$2,046	(a)	$3,773	$3,777
Sewer pipe do	(a)	(a)	(a)	(a)	(a)
Fireproofing do	(a)	(a)	(a)	(a)	(a)
Pottery:					
Red earthenware do	$7,530	$15,058	$11,886	$3,475	$11,243
Stoneware and yellow and Rockingham ware value	$20,215	$9,031	$24,453	$16,371	$14,753
Miscellaneous do	$367,414	$476,070	$404,832	$496,791	$639,941
Total value	$1,754,409	$1,559,606	$1,700,127	$1,667,559	$1,947,102
Number of operating firms reporting	100	103	100	87	82
Rank of State	20	19	22	22	17

CALIFORNIA.

Brick:					
Common—					
Quantity	339,439,000	236,383,000	276,396,000	280,265,000	282,199,000
Value	$2,483,062	$1,593,814	$1,749,209	$1,694,312	$1,716,442
Average per M	$7.32	$6.74	$6.33	$6.05	$6.08
Vitrified—					
Quantity	(a)	3,499,000	7,180,000	8,538,000	9,186,000
Value	(a)	$66,214	$135,203	$140,130	$155,885
Average per M	$15.79	$18.92	$18.83	$16.41	$16.97
Front—					
Quantity	12,922,000	12,393,000	10,359,000	11,475,000	15,197,000
Value	$283,375	$283,701	$309,770	$285,468	$381,226
Average per M	$21.93	$22.89	$29.90	$24.88	$25.09
Fancy or ornamental value	$150,165	$34,947	(a)	$48,572	(a)
Enameled do	(a)	(a)	$57,914	$100,531	$113,407
Fire do	$374,378	$325,760	$297,577	$371,017	$468,120
Stove lining do	(a)	(a)	(a)	(a)	(a)
Draintile do	$53,997	$34,457	$29,620	$55,386	$34,780
Sewer pipe do	$1,086,916	$1,036,320	$904,473	$1,031,061	$999,546
Architectural terra cotta do	$528,623	$500,130	$345,402	$678,249	$475,647
Fireproofing do	$208,205	$188,221	$128,447	$151,503	$200,923
Tile, not drain do	$107,492	$84,484	$130,941	$97,685	$90,632

[a] Included in "Miscellaneous."

Clay products of the United States, by States, from 1907 to 1911—Continued.

CALIFORNIA—Continued.

Product.	1907	1908	1909	1910	1911
Pottery:					
Red earthenware.....value..	$42,856	$42,962	$42,464	$34,367	$32,146
Stoneware and yellow and Rockingham ware..value..	$39,382	$29,300	$59,907	$42,726	$48,190
Sanitary ware.............do....	(a)	(a)	(a)	(a)	(a)
Miscellaneous.............do....	$382,086	$303,435	$246,238	$111,384	$198,922
Total value..................	$5,740,537	$4,523,745	$4,437,165	$4,842,391	$4,915,866
Number of operating firms reporting..........................	118	119	99	107	92
Rank of State...............	8	8	9	9	8

COLORADO.

Product.	1907	1908	1909	1910	1911
Brick:					
Common—					
Quantity................	118,551,000	112,859,000	121,908,000	128,711,000	89,950,000
Value....................	$803,701	$795,733	$601,833	$852,986	$559,519
Average per M...........	$6.78	$7.05	$6.58	$6.63	$6.22
Vitrified—					
Quantity................	3,145,000	2,372,000	(a)	(a)	2,334,000
Value....................	$37,782	$30,262	(a)	(a)	$31,572
Average per M...........	$12.01	$12.76	$14 12	$14.15	$13.53
Front—					
Quantity................	24,572,000	31,667,000	38,782,000	30,334,000	26,189,000
Value....................	$254,522	$364,367	$473,039	$368,538	$294,783
Average per M...........	$10.36	$11.51	$12.20	$12.15	$11.26
Fancy...............value.	$46,128	$34,777	....	(a)	$1,220
Enameled............do ...	(a)	....	....	....	....
Fire..................do....	$430,897	$206,161	$265,089	$205,550	$182,766
Draintile..................do....	$19,608	$16,472	$13,626	$18,066	$23,655
Sewer pipe.................do....	(a)	(a)	(a)	(a)	$297,800
Architectural terra cotta..do....	(a)	(a)	....	....	....
Fireproofing..............do....	(a)	(a)	(a)	$32,565	(a)
Tile, not drain...........do....	(a)	(a)	(a)	(a)	(a)
Pottery:					
Red earthenware......do....	$1,931	$11,250	(a)	(a)	(a)
Stoneware and yellow and Rockingham ware..value..	$35,644	(a)	(a)	(a)	(a)
Miscellaneous.............do....	$411,262	$511,059	$495,437	$556,009	$215,394
Total value................	$2,041,475	$1,970,081	$2,049,024	$2,033,714	$1,606,709
Number of operating firms reporting..........................	88	80	73	77	80
Rank of State...................	16	15	16	17	22

CONNECTICUT AND RHODE ISLAND.

Product.	1907	1908	1909	1910	1911
Brick:					
Common—					
Quantity................	198,414,000	131,760,000	242,000,000	240,234,000	206,631,000
Value....................	$1,240,575	$749,093	$1,408,033	$1,454,471	$1,153,409
Average per M...........	$6.25	$5.69	$5.82	$6.05	$5.58
Vitrified—					
Quantity................	(a)	(a)	(a)	(a)	(a)
Value....................	(a)	(a)	(a)	(a)	(a)
Average per M...........	$24.23	$16.25	$13.00	$14.62	$15.50
Front—					
Quantity................	(a)	(a)	(a)	(a)	(a)
Value....................	(a)	(a)	(a)	(a)	(a)
Average per M...........	$15.44	$15.75	$14.00	$15.75	$12.49
Fancy or ornamental.value..	....	....	(a)	(a)	(a)
Fire..................do....	(a)	(a)	(a)	(a)	(a)
Stove lining...............do....	(a)	(a)	(a)	(a)	(a)
Tile, not drain............do....	....	....	....	....	(a)
Pottery: [b]					
Red earthenware......do....	(a)	(a)	(b)	(b)	(b)
Stoneware and yellow and Rockingham ware..value..	(a)	(a)	(b)	(b)	(b)
Porcelain electrical supplies, value..........................	(a)	(a)	(b)	(b)	(b)

[a] Included in "Miscellaneous."

[b] Produced by Connecticut alone. In 1909, 1910, and 1911 the value of pottery products for Connecticut could not be included in the State totals without disclosing the operations of individual establishments

Clay products of the United States, by States, from 1907 to 1911—Continued.

CONNECTICUT AND RHODE ISLAND—Continued.

Product.	1907	1908	1909	1910	1911
Miscellaneous............value..	$244,017	$152,468	$107,562	$114,015	$103,930
Total value..................	$1,484,592	$901,561	$1,515,595	$1,568,486	$1,257,339
Number of operating firms reporting....................	43	41	42	42	42
Rank of Connecticut and Rhode Island........................	24	27	24	23	25

GEORGIA.

Product.	1907	1908	1909	1910	1911
Brick:					
Common—					
Quantity................	318,844,000	248,585,000	275,809,000	305,025,000	325,948,000
Value....................	$1,807,148	$1,335,349	$1,469,839	$1,620,174	$1,692,610
Average per M...........	$5.67	$5.37	$5.33	$5.31	$5.19
Vitrified—					
Quantity................	(a)	(a)	(a)	(a)	(a)
Value....................	(a)	(a)	(a)	(a)	(a)
Average per M...........	$12.50	$15.50	$12.00	$11.11	$12.22
Front—					
Quantity................	1,625,000	2,929,000	7,188,000	13,649,000	12,788,000
Value....................	$16,450	$34,385	$61,131	$129,393	$112,675
Average per M...........	$10.12	$11.74	$8.50	$9.48	$8.81
Fancy or ornamental.value..	(a)	....	(a)	(a)	....
Fire.....................do....	$82,391	$53,466	$62,452	$67,622	$86,000
Stove lining...............do....	(a)	....	....	....	(a)
Draintile...................do....	$8,050	(a)	$4,820	$8,920	$5,000
Sewer pipe.................do....	$244,000	$253,664	$351,492	$373,387	$417,267
Architectural terra cotta...do....	(a)	(a)	(a)	(a)	(a)
Fireproofing ....do....	(a)	(a)	(a)	$19,354	(a)
Tile, not drain.............do....	(a)	(a)	(a)	$51,800	(a)
Pottery:					
Red earthenware.......do....	$18,440	$5,710	$12,945	$10,558	$17,530
Stoneware and yellow and Rockingham ware..value..	$15,445	$4,941	$16,435	$10,740	$6,800
Miscellaneous.............do....	$298,313	$241,096	$315,387	$240,090	$298,498
Total value.................	$2,490,237	$1,928,611	$2,294,501	$2,532,038	$2,636,380
Number of operating firms reporting.........................	106	108	105	109	109
Rank of State....................	13	16	15	15	13

ILLINOIS.

Product.	1907	1908	1909	1910	1911
Brick:					
Common—					
Quantity................	1,494,807,000	1,119,224,000	1,257,025,000	1,196,526,000	1,074,486,000
Value....................	$6,499,777	$4,834,652	$5,927,054	$6,896,836	$6,126,911
Average per M...........	$4.35	$4.32	$4.72	$5.76	$5.70
Vitrified—					
Quantity................	126,927,000	138,362,000	140,105,000	115,903,000	124,623,000
Value....................	$1,405,821	$1,622,496	$1,562,373	$1,415,355	$1,627,683
Average per M...........	$11.08	$11.73	$11.15	$12.21	$13.06
Front—					
Quantity................	20,828,000	22,851,000	32,416,000	22,138,000	19,786,000
Value....................	$266,270	$301,515	$385,170	$274,699	$240,135
Average per M...........	$12.78	$13.19	$11.88	$12.41	$12.14
Fancy or ornamental.value..	(a)	(a)	$12,223	$10,875	$10,281
Enameled.............do....	(a)	(a)	(a)	(a)	(a)
Fire....................do....	$241,008	$250,444	$682,793	$368,730	$286,039
Stove lining...............do....	(a)	(a)	....	....	....
Draintile...................do....	$1,031,192	$1,421,878	$1,613,593	$1,613,698	$1,372,049
Sewer pipe.................do....	$662,487	$514,386	$394,461	$538,633	$507,694
Architectural terra cotta...do....	(a)	(a)	$1,898,865	$1,680,438	$1,879,275
Fireproofing................do....	$429,535	$264,986	$439,796	$552,905	$552,994
Tile, not drain.............do....	(a)	$124,425	$335,020	(a)	(a)
Pottery:					
Red earthenware.......do....	$37,045	$24,821	$31,771	$25,658	$41,875
Stoneware and yellow and Rockingham ware..value..	$898,267	$733,373	$702,411	$708,958	$832,813

[a] Included in "Miscellaneous."

Clay products of the United States, by States, from 1907 to 1911—Continued.

ILLINOIS—Continued.

Product.	1907	1908	1909	1910	1911
Pottery—Continued.					
White ware, including C. C. ware, white granite, semi-porcelain ware, and semi-vitreous porcelain ware, value	(a)	(a)	(a)		(a)
Sanitary ware........value			(a)	(a)	(a)
Porcelain electrical supplies, value	(a)				(a)
Miscellaneous............value	$1,749,087	$1,466,138	$358,923	$1,089,376	$855,262
Total value	$13,220,489	$11,559,114	$14,344,453	$15,176,161	$14,333,011
Number of operating firms reporting	417	400	379	346	330
Rank of State	4	4	4	4	4

INDIANA.

Product.	1907	1908	1909	1910	1911
Brick:					
Common—					
Quantity	251,766,000	224,454,000	251,227,000	234,297,000	192,057,000
Value	$1,509,415	$1,221,910	$1,579,185	$1,402,154	$1,132,555
Average per M	$6.00	$5.44	$6.29	$5.98	$5.90
Vitrified—					
Quantity	46,224,000	57,748,000	53,597,000	61,034,000	31,198,000
Value	$548,448	$776,533	$559,201	$682,888	$392,136
Average per M	$11.87	$13.45	$10.44	$11.19	$12.57
Front—					
Quantity	36,890,000	34,336,000	50,135,000	46,691,000	40,777,000
Value	$437,796	$403,545	$511,171	$478,627	$480,709
Average per M	$11.87	$11.75	$10.20	$10.25	$11.79
Fancy or ornamental.value	(a)	(a)	(a)	(a)	(a)
Fire..............do	$160,373	$115,895	$280,921	$166,217	$76,116
Stove lining..............do				(a)	(a)
Draintile..............do	$1,437,735	$1,797,329	$2,018,401	$2,071,564	$2,006,803
Sewer pipe..............do	$487,537	$486,949	$332,449	$406,543	$455,014
Architectural terra cotta..do	(a)	(a)	(a)	(a)	(a)
Fireproofing..............do	$414,343	$359,817	$410,500	$466,877	$437,778
Tile, not drain..............do	(a)	$505,908	(a)	$622,726	(a)
Pottery:					
Red earthenware......do	$5,075	$7,450	$10,090	$12,650	$5,700
Stoneware and yellow and Rockingham ware..value	$45,579	$37,020	$59,598	$89,423	$81,567
White ware, including C. C. ware, white granite, semi-porcelain ware, and semi-vitreous porcelain ware, value	(a)	(a)	(a)	(a)	(a)
Sanitary ware........value	$400,000	$250,000	(a)	$468,301	$549,470
Porcelain electrical supplies, value	(a)	(a)	(a)	(a)	(a)
Miscellaneous............value	$1,411,823	$677,814	$1,883,707	$1,232,040	$1,382,923
Total value	$6,858,124	$6,740,167	$7,645,223	$8,100,010	$7,000,771
Number of operating firms reporting	392	369	348	249	302
Rank of State	7	6	6	6	6

IOWA.

Product.	1907	1908	1909	1910	1911
Brick:					
Common—					
Quantity	157,618,000	135,678,000	153,065,000	149,914,000	154,434,000
Value	$1,085,383	$904,308	$1,072,340	$1,088,266	$1,025,011
Average per M	$6.89	$6.67	$7.01	$7.26	$6.64
Vitrified—					
Quantity	21,686,000	16,672,000	18,586,000	19,887,000	8,879,000
Value	$223,193	$185,112	$198,780	$239,283	$103,384
Average per M	$10.29	$11.10	$10.70	$12.03	$11.64
Front—					
Quantity	8,028,000	7,900,000	12,015,000	8,142,000	9,241,000
Value	$96,316	$86,232	$138,218	$103,276	$114,178
Average per M	$12.00	$10.92	$11.50	$12.68	$12.36
Fancy or ornamental.value		(a)	(a)		(a)
Fire..............do	$795		(a)	(a)	

[a] Included in "Miscellaneous."

Clay products of the United States, by States, from 1907 to 1911—Continued.

IOWA—Continued.

Product.	1907	1908	1909	1910	1911
Draintile....value..	$2,011,793	$2,509,505	$2,830,910	$3,337,851	$2,468,962
Sewer pipe....do....	(a)	$211,044	$282,637	$313,430	$284,817
Fireproofing, terra-cotta lumber, and hollow building block or tile....value..	$176,854	$129,003	$304,398	$200,965	$374,628
Pottery:					
Red earthenware....do....	$8,250	$8,161	$8,175	$6,290	$6,936
Stoneware and yellow and Rockingham ware..value..	(a)	$7,549	(a)	(a)	(a)
Miscellaneous....do....	$126,201	$28,583	$63,238	$38,880	$54,958
Total value....	$3,728,785	$4,069,497	$4,898,696	$5,328,241	$4,432,874
Number of operating firms reporting....	276	263	247	232	214
Rank of State....	9	9	8	8	9

KANSAS.

Product.	1907	1908	1909	1910	1911
Brick:					
Common—					
Quantity....	263,887,000	225,820,000	254,890,000	218,353,000	183,809,000
Value....	$1,189,263	$896,542	$1,160,877	$922,940	$694,586
Average per M....	$4.51	$3.97	$4.55	$4.22	$3.78
Vitrified—					
Quantity....	85,110,000	102,922,000	103,264,000	118,950,000	83,337,000
Value....	$727,979	$862,019	$932,419	$1,089,978	$823,505
Average per M....	$8.55	$8.38	$9.03	$9.16	$9.88
Front—					
Quantity....	24,381,000	29,477,000	26,170,000	25,814,000	27,887,000
Value....	$236,876	$233,578	$235,875	$223,875	$213,711
Average per M....	$9.72	$7.92	$9.01	$8.67	$7.66
Fancy or ornamental..value..	(a)	(a)	(a)	(a)	(a)
Fire....do....	(a)	(a)	(a)		(a)
Draintile....do....	$15,320	$22,359	$37,862	$50,726	$35,875
Sewer pipe....do....	(a)	(a)	(a)	(a)	(a)
Architectural terra cotta...do....	(a)	(a)	(a)	(a)	(a)
Fireproofing....do....	(a)	(a)	(a)	(a)	$15,257
Tile, not drain....do....	(a)	(a)	(a)	(a)	(a)
Pottery:					
Stoneware and yellow and Rockingham ware..value..	(b)	(b)	(b)	(b)	(b)
Miscellaneous....do....	$200,620	$234,307	$342,789	$374,008	$577,328
Total value....	$2,370,058	$2,248,805	$2,709,822	$2,661,527	$2,360,262
Number of operating firms reporting....	67	65	58	59	53
Rank of State....	14	11	13	13	15

KENTUCKY.

Product.	1907	1908	1909	1910	1911
Brick:					
Common—					
Quantity....	143,731,000	110,545,000	119,183,000	115,890,000	107,771,000
Value....	$932,469	$687,365	$741,115	$743,732	$692,378
Average per M....	$6.49	$6.22	$6.22	$6.42	$6.42
Vitrified—					
Quantity....	(a)	(a)	(a)	(a)	(a)
Value....	(a)	(a)	(a)	(a)	(a)
Average per M....	$14.27	$13.26	$12.69	$12.74	$12.37
Front—					
Quantity....	7,926,000	11,067,000	11,626,000	10,238,000	8,972,000
Value....	$86,568	$119,785	$104,022	$99,532	$90,330
Average per M....	$10.92	$10.82	$8.95	$9.72	$10.07
Fancy....value..			(a)	(a)	
Fire....do....	$940,415	$770,221	$899,363	$955,557	$890,810
Stove lining....do....			(a)		
Draintile....do....	$32,723	$53,308	$53,213	$66,217	$64,005
Sewer pipe....do....	(a)	(a)	(a)	(a)	(a)

[a] Included in "Miscellaneous."

[b] The value of pottery products for Kansas could not be included in the State totals without disclosing the operations of individual establishments.

Clay products of the United States, by States, from 1907 to 1911—Continued.

KENTUCKY—Continued.

Product.	1907	1908	1909	1910	1911
Architectural terra cotta..value..			(a)		
Fireproofing................do....	(a)	$7,263	(a)	(a)	(a)
Tile, not drain............do....	$255,054	$215,000	$296,179	$318,966	$292,563
Pottery:					
Red earthenware......do....	$27,546	$23,448	$20,225	$10,004	$12,880
Stoneware and yellow and Rockingham ware..value..	$139,075	$130,200	$126,172	$139,417	$101,214
Miscellaneous............do....	$197,514	$232,518	$238,583	$234,112	$223,914
Total value...............	$2,611,364	$2,239,108	$2,478,872	$2,567,537	$2,368,094
Number of operating firms reporting....................	115	116	99	95	96
Rank of State..................	11	12	14	14	14

MARYLAND.

Product.	1907	1908	1909	1910	1911
Brick:					
Common—					
Quantity................	166,768,000	141,071,000	148,673,000	164,795,000	160,229,000
Value.....................	$1,026,922	$828,981	$914,420	$1,051,381	$999,791
Average per M..........	$6.16	$5.88	$6.15	$6.38	$6.24
Vitrified—					
Quantity................	(a)	(a)	(a)	(a)	(a)
Value....................	(a)	(a)	(a)	(a)	(a)
Average per M..........	$15.00	$13.06	$13.10	$16.96	$16.98
Front—					
Quantity................	1,597,000	936,000	1,350,000	260,000	757,000
Value.....................	$19,854	$13,498	$20,582	$3,953	$10,574
Average per M..........	$12.43	$14.42	$15.25	$15.20	$13.97
Fancy or ornamental.value..	(a)	$1,463	(a)	(a)	(a)
Enameled.............do....	(a)	(a)	(a)	(a)	(a)
Fire.....................do....	$242,312	$179,469	$278,777	$296,541	$249,674
Stove lining...............do....	$31,048	$23,538	$25,925	$23,067	$28,469
Draintile..................do....	$3,190	$3,895	$5,695	$5,899	$8,048
Architectural terra cotta...do....	(a)	(a)	(a)	(a)	(a)
Tile, not drain.............do....	(a)	(a)			(a)
Pottery:					
Red earthenware......do....	$12,895	$9,267	$8,034	$9,171	$8,281
Stoneware and yellow and Rockingham ware..value..	(a)	(a)	(a)		(a)
White ware, including C. C. ware, white granite ware, semiporcelain and semivitreous porcelain ware, value..................	$348,890	(a)	(a)	(a)	(a)
Sanitary ware........value..			(a)	(a)	(a)
Miscellaneous.............do....	$201,251	$380,988	$467,379	$458,261	$467,597
Total value...............	$1,886,362	$1,441,099	$1,720,812	$1,848,273	$1,772,434
Number of operating firms reporting....................	63	65	59	55	56
Rank of State..................	18	22	21	19	18

MASSACHUSETTS.

Product.	1907	1908	1909	1910	1911
Brick:					
Common—					
Quantity................	184,005,000	141,591,000	183,584,000	165,315,000	166,834,000
Value.....................	$1,294,918	$950.921	$1,177,281	$1,120,924	$1,079,778
Average per M..........	$7.04	$6.72	$6.41	$6.78	$6.47
Front—					
Quantity................	(a)	1,899,000	1,790,000	(a)	(a)
Value.....................	(a)	$34,055	$45,050	(a)	(a)
Average per M..........	$37.13	$17.93	$25.17	$15.44	$18.00
Fancy or ornamental, value..	(a)	(a)	(a)		
Fire.....................do....	$74,115	$63,241	$75,160	$71,780	$70,104
Stove lining...............do....	$206,042	$169,811	$159,530	$166,018	$167,802
Architectural terra cotta..do....	(a)		(a)		
Fireproofing................do....	(a)	(a)	(a)	(a)	(a)
Tile, not drain............do....	$123,220	$104,386	$69,837	(a)	(a)

(a) Included in "Miscellaneous."

Clay products of the United States, by States, from 1907 to 1911—Continued.

MASSACHUSETTS—Continued.

Product.	1907	1908	1909	1910	1911
Pottery:					
Red earthenware.....value..	$166,978	$150,148	$154,887	$148,909	$150,038
Stoneware and yellow and Rockingham ware..value..	$17,693	$15,409	$14,380	$9,654	$13,541
White ware, including C. C. ware, white granite ware, semiporcelain and semivitreous porcelain ware, value....................	(*a*)	(*a*)	(*a*)	(*a*)	(*a*)
Porcelain electrical supplies, value....................	(*a*)	(*a*)	(*a*)	(*a*)	(*a*)
Miscellaneous............value..	$245,854	$159,391	$191,761	$190,128	$219,024
Total value................	$2,128,820	$1,647,362	$1,887,886	$1,707,413	$1,700,287
Number of operating firms reporting......................	80	76	72	71	68
Rank of State....................	15	18	19	21	20

MICHIGAN.

Product.	1907	1908	1909	1910	1911
Brick:					
Common—					
Quantity................	200,817,000	181,049,000	219,820,000	232,551,000	252,465,000
Value....................	$1,181,015	$994,525	$1,250,787	$1,363,316	$1,301,998
Average per M...........	$5.88	$5.49	$5.69	$5.86	$5.16
Vitrified—					
Quantity................	7,911,000	6,165,000	10,473,000	9,080,000	5,597,000
Value....................	$94,601	$76,630	$129,283	$116,446	$78,336
Average per M...........	$11 96	$12.43	$12.34	$12.82	$14.00
Front—					
Quantity................	3,956,000	1,896,000	2,379,000	2,209,000	2,498,000
Value....................	$32,116	$19,496	$18,654	$27,533	$31,572
Average per M...........	$8.12	$10.28	$7.84	$12.46	$12.64
Fire..................value..	(*a*)	....	....	....	(*a*)
Stove lining ....do....	....	....	....	(*a*)	(*a*)
Draintile ....do....	$289,868	$327,630	$364,006	$348,205	$313,072
Sewer pipe................do....	(*a*)	(*a*)	(*a*)	(*a*)	(*a*)
Fireproofing, terra-cotta lumber, and hollow building tile, or blocks...................value..	$6,386	$4,100	(*a*)	....	(*a*)
Tile, not drain............do....	(*a*)	(*a*)	(*a*)	(*a*)	(*a*)
Pottery:					
Red earthenware.......do....	$54,474	$54,659	$60,939	$90,450	$80,580
Porcelain electrical supplies, value....................	....	....	....	(*a*)	(*a*)
Miscellaneous............value..	$189,304	$251,750	$218,829	$250,272	$278,374
Total value................	$1,847,764	$1,728,790	$2,042,498	$2,196.222	$2,083,932
Number of operating firms reporting......................	136	132	122	118	111
Rank of State....................	19	17	17	16	16

MINNESOTA.

Product.	1907	1908	1909	1910	1911
Brick:					
Common—					
Quantity................	168,931,000	145,712,000	161,585,000	182,895,000	153,015,000
Value....................	$1,045,874	$869,532	$969,729	$1,104,898	$868,037
Average per M...........	$6.19	$5.97	$6.00	$6.04	$5.67
Vitrified—					
Quantity................	(*a*)	(*a*)	(*a*)	....	(*a*)
Value....................	(*a*)	(*a*)	(*a*)	....	(*a*)
Average per M...........	$12.00	$9.00	$9.00	....	$13.16
Front—					
Quantity................	(*a*)	9,900,000	14,350,000	7,240,000	10,853,000
Value....................	(*a*)	$118,860	$171,600	$88,000	$135,085
Average per M...........	$12.93	$12.01	$11.96	$12.15	$12.45
Fancy or ornamental.value..	(*a*)	(*a*)	....	....	....
Fire......................do....	(*a*)	(*a*)	....	(*a*)	(*a*)
Draintile..................do....	$49,622	$70,161	$109,371	$160,706	$121,965
Sewer pipe................do....	(*a*)	(*a*)	(*a*)	(*a*)	(*a*)
Fireproofing..............do....	$42,327	$45,940	$53,398	$93,731	$109,812
Tile, not drain............do....	....	....	(*a*)	....	(*a*)

[a] Included in "Miscellaneous."

Clay products of the United States, by States, from 1907 to 1911—Continued.

MINNESOTA—Continued.

Product.	1907	1908	1909	1910	1911
Pottery:					
Earthenware and stoneware, value	(b)	(b)	(b)	(b)	(b)
Miscellaneous.............value..	$552,100	$404,217	$451,340	$453,961	$458,579
Total value................	$1,689,933	$1,508,710	$1,755,438	$1,901,296	$1,693,478
Number of operating firms reporting..........	106	92	80	84	81
Rank of State..........	21	20	20	18	21

MISSOURI.

Product.	1907	1908	1909	1910	1911
Brick:					
Common—					
Quantity..............	264,462,000	219,526,000	276,403,000	201,281,000	217,466,000
Value..............	$1,844,255	$1,465,311	$1,961,805	$1,284,997	$1,309,164
Average per M..........	$6.97	$6.67	$7.10	$6.38	$6.02
Vitrified—					
Quantity..............	47,807,000	56,805,000	59,863,000	56,703,000	44,813,000
Value..............	$462,341	$647,097	$781,706	$647,441	$488,299
Average per M..........	$9.67	$11.39	$13.06	$11.42	$10.90
Front—					
Quantity..............	30,178,000	32,136,000	36,194,000	38,428,000	25,491,000
Value..............	$387,455	$356,758	$589,782	$516,505	$330,332
Average per M..........	$12.84	$11.10	$16.30	$13.44	$12.96
Fancy or ornamental. value..	$33,638	$25,035	$29,683	$23,673	$24,269
Enameled.............do....	(a)	(a)	(a)	(a)	(a)
Fire.................do....	$1,634,209	$1,357,387	$1,598,302	$2,059,845	$1,763,548
Stove lining..........do....	(a)	(a)	(a)	(a)	(a)
Draintile.............do....	$72,316	$76,865	$127,166	$121,068	$164,393
Sewer pipe...........do....	$1,332,080	$962,116	$1,162,730	$1,210,348	$1,156,626
Architectural terra cotta .do....	(a)	(a)	(a)	(a)	$402,969
Fireproofing, terra-cotta lumber, and hollow building tile or blocks..........value.	$142,997	$105,136	$110,464	$146,931	$123,499
Tile, not drain..........do ..	(a)	(a)	(a)	(a)	(a)
Pottery:					
Red earthenware...... do ..	$3,289	$3,719	$4,792	$3,080	$2,755
Stoneware and yellow and Rockingham ware..value	$69,323	$62,689	$66,830	$25,981	$2,453
Miscellaneous.............do....	$916,968	$569,343	$1,006,923	$1,047,897	$506,046
Total value..............	$6,898,871	$5,631,456	$7,440,183	$7,087,766	$6,274,353
Number of operating firms reporting..........	172	161	156	150	122
Rank of State..........	6	7	7	7	7

NEBRASKA.

Product.	1907	1908	1909	1910	1911
Brick:					
Common—					
Quantity..............	117,276,000	114,399,000	139,151,000	119,017,000	102,706,000
Value..............	$789,170	$766,146	$946,532	$791,351	$657,001
Average per M..........	$6.73	$6.70	$6.80	$6.65	$6.40
Vitrified—					
Quantity..............	2,900,000	(a)	(a)	(a)	(a)
Value..............	$24,600	(a)	(a)	(a)	(a)
Average per M..........	$8.48	$7.59	$10.50	$8.88	$11.55
Front—					
Quantity..............	7,280,000	(a)	(a)	(a)	(a)
Value..............	$100,654	(a)	(a)	(a)	(a)
Average per M..........	$13.83	$13.99	$18.17	$16.00	$20.00
Fancy..............value..	(a)	(a)	....	....	....
Fire.................do....	....	(a)	....	....	....
Draintile..............do....	(a)	$12,346	(a)	(a)	$14,339
Fireproofing..............do....	$29,000	$63,191	(a)	(a)	(a)
Miscellaneous.............do....	$10,008	$104,833	$199,917	$147,476	$124,554
Total value..............	$953,432	$946,516	$1,146,449	$938,827	$795,894
Number of operating firms reporting..........	89	90	79	78	68
Rank of State..........	27	25	26	27	28

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[a] Included in "Miscellaneous."

[b] The value of pottery products for Minnesota could not be included in the State totals without disclosing the operations of individual establishments.

Clay products of the United States, by States, from 1907 to 1911—Continued.

NEW JERSEY.

Product.	1907	1908	1909	1910	1911
Brick:					
Common—					
Quantity	388,735,000	300,544,000	460,966,000	401,103,000	429,367,000
Value	$2,289,883	$1,579,835	$2,609,605	$2,215,628	$2,401,962
Average per M	$5.89	$5.26	$5.66	$5.52	$5.59
Vitrified—					
Quantity	(*a*)	(*a*)	(*a*)	....	(*a*)
Value	(*a*)	(*a*)	(*a*)	....	(*a*)
Average per M	$13.31	$11.43	$11.41	....	$14.99
Front—					
Quantity	61,521,000	64,302,000	80,855,000	47,451,000	47,606,000
Value	$825,767	$667,682	$862,245	$609,845	$528,656
Average per M	$13.42	$10.38	$10.66	$12.85	$11.10
Fancy or ornamental . value	$4,605	$3,619	$8,578	(*a*)	(*a*)
Enameled do	(*a*)	(*a*)	(*a*)	(*a*)	(*a*)
Fire do	$947,472	$800,987	$907,276	$1,001,063	$1,344,884
Stove lining do	(*a*)	(*a*)	....	(*a*)	(*a*)
Draintile do	$21,869	$30,325	$37,211	$23,147	$26,502
Sewer pipe do	(*a*)	(*a*)	(*a*)	(*a*)	$103,137
Architectural terra cotta do	$1,722,067	$1,039,856	$1,637,705	$2,000,039	$1,669,973
Fireproofing, terra-cotta lumber, and hollow building tile or blocks value	$1,159,467	$826,224	$1,299,540	$1,582,101	$1,728,811
Tile, not drain do	$1,050,085	$835,499	$992,606	$1,199,113	$1,197,330
Pottery:					
Red earthenware value	$21,067	$20,100	$36,573	$26,529	$38,910
Stoneware and yellow and Rockingham ware. value	(*a*)	(*a*)	$66,293	$55,734	$75,915
White ware, including C. C. ware, white granite semi-porcelain ware, and semi-vitreous porcelain ware, value	$1,225,691	$1,137,701	$1,242,361	$1,345,156	$1,148,904
China, bone china, delft, and belleek ware value	$1,135,885	$876,259	$1,082,398	$1,131,412	$1,105,278
Sanitary ware do	$3,615,685	$3,182,772	$4,341,040	$4,955,066	$4,898,588
Porcelain electrical supplies, value	$744,068	$559,556	$823,056	$874,013	$913,921
Miscellaneous value	$1,241,849	$753,281	$1,225,607	$815,463	$995,457
Total value	$16,005,460	$12,313,696	$17,172,094	$17,834,309	$18,178,228
Number of operating firms reporting	165	165	165	167	162
Rank of State	3	3	3	3	3

NEW YORK.

Brick:					
Common—					
Quantity	1,319,416,000	1,055,006,000	1,542,552,000	1,380,084,000	1,143,726,000
Value	$7,056,453	$5,066,084	$7,760,746	$6,897,438	$5,918,286
Average per M	$5.35	$4.80	$5.03	$5.00	$5.17
Vitrified—					
Quantity	18,516,000	14,570,000	16,063,000	21,662,000	17,035,000
Value	$253,664	$211,290	$238,697	$334,432	$290,728
Average per M	$13.70	$14.50	$14.86	$15.44	$17.07
Front—					
Quantity	12,265,000	9,721,000	9,815,000	9,229,000	9,942,000
Value	$198,265	$135,342	$148,126	$137,748	$133,563
Average per M	$16.17	$13.92	$15.09	$14.93	$13.43
Fancy or ornamental. value	(*a*)	(*a*)	....	(*a*)	(*a*)
Fire do	$538,721	$436,847	$491,872	$514,990	$347,415
Stove lining do	$129,467	$102,985	$79,653	$86,248	$82,803
Draintile do	$180,818	$275,681	$125,640	$272,836	$112,609
Sewer pipe do	(*a*)	$133,716	$126,908	$136,576	$116,184
Architectural terra cotta do	$1,089,278	$709,360	$998,535	$1,108,371	$673,529
Fireproofing do	$120,318	$122,395	$199,999	$210,954	$227,871
Tile, not drain do	$43,726	$40,066	$62,795	$72,815	$86,602
Pottery:					
Earthernware value	$32,896	$31,645	$30,200	$26,863	$34,295
Stoneware and yellow and Rockingham ware value	$87,471	$44,713	$46,905	$43,325	$40,946
White ware, including C. C. ware, white granite, semi-porcelain ware, and semi-vitreous porcelain ware, value	(*a*)	(*a*)	(*a*)	(*a*)	(*a*)

[a] Included in "Miscellaneous."

Clay products of the United States, by States, from 1907 to 1911—Continued.

NEW YORK—Continued.

Product.	1907	1908	1909	1910	1911
Pottery—Continued.					
China, bone china, delft and belleek ware........value..	$746,634	$622,548	$592,611	$642,592	$730,983
Sanitary ware..........do....	(a)	(a)	(a)	(a)	(a)
Porcelain electrical supplies, value..........................	$626,032	$560,754	$752,185	$957,101	$988,716
Miscellaneous............value..	$669,131	$435,798	$502,564	$429,660	$399,846
Total value................	$11,772,874	$8,929,224	$12,157,436	$11,871,949	$10,184,376
Number of operating firms reporting.........................	247	241	243	240	222
Rank of State..................	5	5	5	5	5

NORTH CAROLINA.

Product.	1907	1908	1909	1910	1911
Brick:					
Common—					
Quantity................	174,800,000	144,192,000	188,313,000	167,966,000	178,235,00
Value....................	$1,150,685	$900,611	$1,140,727	$1,039,319	$1,076,18
Average per M...........	$6.58	$6.25	$6.06	$6.19	$6.0
Vitrified—					
Quantity................	(a)	(a)	....	....	....
Value....................	(a)	(a)	....	....	....
Average per M...........	$10.00	$8.00	....	....	....
Front—					
Quantity................	770,000	300,000	725,000	550,000	(a)
Value....................	$7,925	$2,700	$9,250	$5,800	(a)
Average per M...........	$10.29	$9.00	$12.76	$10.55	$9.8
Fire..................value..	(a)	$7,560	....	....	(a)
Draintile.................do....	(a)	$1,635	$8,890	$9,555	$11,70
Sewer pipe................do....	(a)	(a)	(a)	(a)	(a)
Fireproofing..............do....	....	(a)	....	(a)	(a)
Pottery:					
Red earthenware.......do....	$2,382	$775	$1,780	$1,961	$1,33
Stoneware and yellow and Rockingham ware..value..	$7,840	$12,587	$16,929	$13,029	$7,22
Miscellaneous.............do....	$146,990	$18,100	$125,035	$154,000	$183,68
Total value................	$1,315,822	$943,968	$1,302,611	$1,223,664	$1,280,12
Number of operating firms reporting.........................	215	216	187	184	1
Rank of State..................	25	26	25	25	2

OHIO.

Product.	1907	1908	1909	1910	1911
Brick:					
Common—					
Quantity................	495,025,000	369,410,000	420,999,000	409,773,000	389,515,0
Value....................	$3,012,485	$2,105,910	$2,429,879	$2,507,742	$2,299,1
Average per M...........	$6.09	$5.70	$5.77	$6.12	$5.
Vitrified—					
Quantity................	264,571,000	327,718,000	324,530,000	289,817,000	315,944,0
Value....................	$2,672,600	$3,232,335	$3,113,128	$2,876,157	$3,200,4
Average per M...........	$10.10	$9.86	$9.59	$9.92	$10.
Front—					
Quantity................	88,992,000	94,435,000	130,684,000	134,759,000	159,118,0
Value....................	$1,033,434	$1,067,888	$1,393,787	$1,489,094	$1,630,8
Average per M...........	$11.61	$11.31	$10.67	$11.05	$10.
Fancy or ornamental.value..	$24,468	$39,309	$24,367	$32,995	$25,3
Fire.....................do....	$1,668,728	$1,339,810	$1,730,401	$1,709,039	$1,539,4
Stove lining.................do....	$22,416	(a)	$23,803	(a)	$86,6
Draintile.....................do....	$1,433,341	$1,725,462	$2,032,528	$1,869,823	$1,684,4
Sewer pipe..................do....	$3,792,352	$3,918,971	$3,009,798	$3,289,537	$3,445,6
Architectural terra cotta..do....	(a)	....	(a)	....	....
Fireproofing, terra-cotta lumber, and hollow building tile or blocks....................value..	$1,006,076	$552,887	$804,637	$934,960	$1,086,2
Tile, not drain............do....	$1,586,174	$1,438,042	$1,912,343	$1,896,572	$2,312,4
Pottery:					
Red earthenware.......do....	$142,042	$138,431	$145,137	$161,799	$233,
Stoneware and yellow and Rockingham ware..value..	$1,648,213	$1,468,197	$1,806,798	$1,664,572	$1,758,

a Included in "Miscellaneous."

Clay products of the United States, by States, from 1907 to 1911—Continued.

OHIO—Continued.

Product.	1907	1908	1909	1910	1911
Pottery—Continued.					
White ware, including C. C. ware, white granite, semi-porcelain ware, and semi-vitreous porcelain ware, value	$9,419,960	$7,228,636	$8,884,189	$9,730,408	$9,612,315
China, bone china, delft and belleek ware........value..	(*a*)	(*a*)	(*a*)	....	....
Sanitary ware.........do....	$226,000	$233,000	$310,254	$327,438	$378,779
Porcelain electrical supplies, value	$933,256	$719,034	$1,146,694	$1,277,144	$1,610,925
Miscellaneous............value..	$1,719,285	$1,414,578	$1,578,498	$1,758,668	$1,759,211
Total value	$30,340,830	$26,622,490	$30,346,241	$31,525,948	$32,663,895
Number of operating firms reporting	736	706	685	683	633
Rank of State	1	1	1	1	1

OKLAHOMA.

Product.	1907	1908	1909	1910	1911
Brick:					
Common—					
Quantity	88,124,000	74,836,000	156,889,000	131,146,000	102,013,000
Value	$590,488	$457,588	$952,453	$763,236	$528,287
Average per M	$6.70	$6.11	$6.07	$5.82	$5.18
Vitrified—					
Quantity	4,528,000	7,681,000	7,186,000	11,959,000	19,535,000
Value	$39,676	$71,545	$58,388	$114,315	$201,100
Average per M	$8.76	$9.31	$8.13	$9.56	$10.29
Front—					
Quantity	1,752,000	1,231,000	1,796,000	2,682,000	2,551,000
Value	$20,990	$16,010	$21,473	$35,288	$24,703
Average per M	$11.98	$13.01	$11.96	$13.16	$9.68
Fancy or ornamental.value..	....	(*a*)	....	....	....
Fire..................do....	(*a*)	(*a*)	....	....	....
Draintile..................do....	....	(*a*)	....	....	....
Miscellaneous.............do....	$13,358	$17,786	....	$8,082	$2,549
Total value	$664,512	$562,929	$1,032,314	$920,921	$756,639
Number of operating firms reporting	41	33	39	46	40
Rank of State	31	32	23	23	29

PENNSYLVANIA.

Product.	1907	1908	1909	1910	1911
Brick:					
Common—					
Quantity	980,102,000	717,016,000	872,658,000	828,703,000	774,122,000
Value	$6,353,799	$4,539,978	$5,607,490	$5,371,707	$4,963,232
Average per M	$6.48	$6.33	$6.43	$6.48	$6.41
Vitrified—					
Quantity	115,729,000	90,044,000	116,735,000	101,330,000	124,125,000
Value	$1,232,718	$1,038,254	$1,329,317	$1,204,724	$1,511,061
Average per M	$10.65	$11.53	$11.39	$11.89	$12.17
Front—					
Quantity	134,869,000	124,642,000	194,395,000	171,415,000	184,569,000
Value	$1,526,565	$1,403,594	$2,111,556	$2,001,967	$2,111,492
Average per M	$11.32	$11.26	$10.85	$11.68	$11.44
Fancy or ornamental.value..	$17,727	$49,199	$27,963	$35,768	$44,883
Enameled ....do....	(*a*)	(*a*)	(*a*)	(*a*)	(*a*)
Fire..................do....	$6,907,904	$4,252,325	$8,107,807	$6,454,928	$5,555,529
Stove lining..............do....	$179,218	$129,686	$97,270	$132,567	$164,848
Draintile.................do....	$10,386	$14,904	$14,668	$11,480	$12,779
Sewer pipe................do....	$795,991	$578,800	$445,594	$583,418	$560,809
Architectural terra cotta...do....	$507,116	$389,596	$428,522	$472,150	$389,000
Fireproofing, terra-cotta lumber, hollow building tile or blocks...............value..	$244,773	$241,175	$324,860	$300,187	$300,687
Tile, not drain...........do....	$406,269	$337,948	$441,243	$413,047	$358,913

a Included in "Miscellaneous."

Clay products of the United States, by States, from 1907 to 1911—Continued.

PENNSYLVANIA—Continued.

Product.	1907	1908	1909	1910	1911
Pottery:					
Red earthenware......value..	$164,096	$138,181	$159,796	$178,348	$159,42
Stoneware and yellow and Rockingham ware..value..	$380,361	$259,095	$297,029	$323,990	$304,9
White ware, including C. C. ware, white granite ware, semiporcelain ware, and semivitreous porcelain ware................value..	$531,634	$623,544	$812,338	(a)	(a)
China, bone china, delft, and belleek ware........value..	(a)	$69,994	$91,757	$188,122	$216,7
Sanitary ware..........do....	$192,854	$175,384	$252,951	$254,747	$215,5
Porcelain electrical supplies, value..........			(a)	(a)	(a)
Miscellaneous............value..	$840,210	$601,325	$636,552	$4,167,135	$3,400,0
Total value................	$20,291,621	$14,842,982	$21,186,713	$22,094,285	$20,270,0
Number of operating firms reporting..................	487	466	457	451	4
Rank of State..................	2	2	2	2	

TENNESSEE.

Product.	1907	1908	1909	1910	1911
Brick:					
Common—					
Quantity................	170,972,000	134,171,000	159,328,000	140,878,000	144,824,0
Value....................	$1,036,112	$767,773	$1,022,282	$826,533	$842,8
Average per M..........	$6.06	$5.72	$6.42	$5.87	$5.
Vitrified—					
Quantity................	(a)	(a)	(a)	(a)	(a)
Value....................	(a)	(a)	(a)	(a)	(a)
Average per M..........	$11.98	$11.46	$13.08	$10.80	$10.
Front—					
Quantity................	15,514,000	9,494,000	11,397,000	10,119,000	9,547,0
Value....................	$169,616	$103,228	$125,661	$98,450	$94,7
Average per M..........	$10.93	$10.87	$11.03	$9.73	$9.
Fancy..................value..	$3,087	$1,505	(a)	(a)	(a)
Fire.....................do....	$40,959	$21,029	(a)	$14,907	$15,9
Draintile...................do....	$28,000	$36,114	$67,472	$29,707	$51,7
Sewer pipe.................do....	(a)	(a)	(a)	(a)	(a)
Fireproofing...............do....	(a)	(a)	(a)	(a)	(a)
Pottery:					
Red earthenware.......do....	$6,185	(a)	(a)	$4,540	$3,9
Stoneware and yellow and Rockingham ware..value..	$111,030	$56,532	$35,100	$44,640	$38,7
Miscellaneous.............do....	$218,873	$250,253	$398,357	$395,511	$337,1
Total value................	$1,613,862	$1,236,434	$1,648,872	$1,414,288	$1,385,1
Number of operating firms reporting..................	116	104	100	97	
Rank of State..................	22	23	23	24	

TEXAS.

Product.	1907	1908	1909	1910	1911
Brick:					
Common—					
Quantity................	243,853,000	194,551,000	293,660,000	271,640,000	255,811,0
Value....................	$1,707,812	$1,285,857	$1,890,601	$1,779,062	$1,596,7
Average per M..........	$7.00	$6.61	$6.44	$6.55	$6.
Vitrified—					
Quantity................	(a)	(a)	(a)	(a)	(a)
Value....................	(a)	(a)	(a)	(a)	(a)
Average per M..........	$10.36	$10.81	$10.32	$13.67	$15.
Front—					
Quantity................	11,494,000	10,411,000	26,726,000	21,646,000	19,331,0
Value....................	$153,187	$154,298	$407,023	$325,074	$297,8
Average per M..........	$13.33	$14.82	$15.23	$15.02	$15.
Fancy or ornamental.value..			(a)		
Fire.....................do....	$75,946	$69,039	$123,393	$75,950	$78,2
Draintile...................do....	(a)	$5,275	$28,414	$18,408	$12,8
Sewer pipe.................do....	(a)	(a)	(a)	(a)	(a)

a Included in "Miscellaneous."

Clay products of the United States, by States, from 1907 to 1911—Continued.

TEXAS—Continued.

Product.	1907	1908	1909	1910	1911
Fireproofing.............value..		(a)	$20,170	(a)	$47,038
Tile, not drain.............do....		(a)			
Pottery:					
Red earthenware......do....	$6,759	$10,267	$10,889	$6,481	$8,963
Stoneware and yellow and Rockingham ware..value..	$149,414	$114,879	$111,539	$112.604	$123.454
Miscellaneous.............do....	$464,443	$427,120	$556,434	$546,351	$494,807
Total value................	$2.557.561	$2,066,735	$3,148,463	$2.863,930	$2.659.919
Number of operating firms reporting..............	131	122	113	124	118
Rank of State....................	12	14	11	12	12

VIRGINIA.

Product.	1907	1908	1909	1910	1911
Brick:					
Common—					
Quantity................	197,052,000	185,738.000	249.794.000	229.982.000	219,035,000
Value.....................	$1,285.374	$1,219,946	$1,540.648	$1,460,460	$1,374.439
Average per M...........	$6.52	$6.57	$6.17	$6.35	$6.27
Front—					
Quantity................	19,989.000	17,858.000	24,717.000	20.813,000	21,032,000
Value.....................	$290.411	$246,623	$333 057	$294.348	$314,201
Average per M...........	$14.53	$13.81	$13.47	$14.14	$14.94
Fancy or ornamental.value..	(a)	(a)	(a)	(a)	(a)
Fire..................do....	(a)	(a)	(a)	(a)	(a)
Draintile..................do....	$6,250	$7,100	$6,298	$5,276	$10,875
Sewer pipe................do....		(a)	(a)	(a)	(a)
Sanitary ware.............do....					(a)
Porcelain electrical supplies, value..........................	(b)	(b)	(a)	(a)	
Miscellaneous............value..	$29,300	$25,461	$76,514	$79,603	$40,385
Total value................	$1,611,335	$1.499.130	$1.956.517	$1.839.687	$1,739,900
Number of operating firms reporting..............	87	80	89	84	77
Rank of State....................	23	21	18	20	19

WASHINGTON.

Product.	1907	1908	1909	1910	1911
Brick:					
Common—					
Quantity................	101,905,000	107,638,000	143,198,000	130,634,000	99,588,000
Value.....................	$840,971	$817,962	$1,081,579	$956,510	$695,100
Average per M...........	$8.31	$7.60	$7.55	$7.32	$6.98
Vitrified—					
Quantity................	(a)	(a)	(a)	(a)	40,291,000
Value.....................	(a)	(a)	(a)	(a)	$743,352
Average per M...........	$18.22	$19.82	$18.72	$18.87	$18.45
Front—					
Quantity................	4,539 000	4,011,000	7,802,000	5,570,000	5,224,000
Value.....................	$127,245	$112,749	$155,600	$124,952	$118,615
Average per M...........	$28.03	$28.11	$19.94	$22.43	$22.71
Fancy.................value..					(a)
Fire..................do....	$43,940	$42,045	$103,531	$25,017	$63,654
Stove lining..............do....					(a)
Draintile..................do....	$17,025	$28,551	$18,495	$34,128	$29,314
Sewer pipe................do....	$482,870	$493,165	$737,847	$817.086	$738,473
Architectural terra cotta...do....	$94,795	$171,845	$206,324	$198,358	$283,608
Fireproofing..............do....	(a)	$45,205	$71,067	$114,501	$153,180
Pottery:					
Red earthenware.....value..	$2,500	$2,450	(a)	(c)	(c)
Stoneware and yellow and Rockingham ware..value..	$28,195	(a)	(a)	(c)	(c)
Miscellaneous.............do....	$278,393	$390,317	$686,043	$753,302	$758,428
Total value................	$1,921,934	$2,104,289	$3,060,486	$3,023,854	$2,840,372
Number of operating firms reporting..............	63	67	65	65	55
Rank of State....................	17	13	12	11	11

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[a] Included in "Miscellaneous."

[b] The value of pottery products for Virginia for 1907 and 1908 could not be included in the State total without disclosing individual figures.

[c] The value of pottery products for Washington for 1910 and 1911 could not be included in the State totals without disclosing the operations of individual establishments.

Clay products in the United States, by States, from 1907 to 1911—Continued.

WEST VIRGINIA.

Product.	1907	1908	1909	1910	1911
Brick:					
Common—					
Quantity	58,102,000	47,402,000	53,983,000	77,916,000	59,961,000
Value	$384,007	$300,776	$327,141	$508,422	$400,916
Average per M	$6.61	$6.35	$6.06	$6.53	$6.69
Vitrified—					
Quantity	60,681,000	70,924,000	45,661,000	46,098,000	56,956,000
Value	$952,060	$718,017	$565,218	$564,578	$681,747
Average per M	$15.69	$10.12	$12.38	$12.25	$11.97
Front—					
Quantity	(a)	(a)	(a)	(a)	(a)
Value	(a)	(a)	(a)	(a)	(a)
Average per M	$15.16	$14.18	$14.74	$10.00	$14.98
Fire ... value	$34,438	$38,943	$80,773	$32,003	$74,596
Draintile ... do	$1,211	$2,645	(a)	$2,330	$3,487
Sewer pipe ... do		(a)	(a)	(a)	(a)
Fireproofing ... do	(a)	(a)	(a)	(a)	(a)
Tile, not drain ... do	$52,429	$49,220	$82,461	$104,633	$136,586
Pottery:					
Stoneware and yellow and Rockingham ware ... value	(a)	(a)	(a)	(a)	(a)
White ware, including C. C. ware, white granite ware, semiporcelain ware, and semivitreous porcelain ware ... value	$1,651,732	$1,612,321	$1,769,808	$1,894,429	$1,920,294
China, bone china, delft, and belleek ware ... value					(a)
Sanitary ware ... do	$378,000	$385,000	$500,432	$618,868	$814,599
Porcelain electrical supplies, value	(a)	(a)		(a)	(a)
Miscellaneous ... value	$186,510	$154,814	$184,264	$272,782	$301,195
Total value	$3,640,387	$3,261,736	$3,510,097	$3,998,045	$4,333,420
Number of operating firms reporting	63	60	50	56	55
Rank of State	10	10	10	10	10

WISCONSIN.

Product.	1907	1908	1909	1910	1911
Brick:					
Common—					
Quantity	158,602,000	129,041,000	147,741,000	161,083,000	151,331,000
Value	$1,019,522	$830,249	$956,232	$1,071,457	$985,824
Average per M	$6.43	$6.43	$6.47	$6.65	$6.51
Vitrified—					
Quantity	(a)				
Value	(a)				
Average per M	$8.04				
Front—					
Quantity	4,106,000	4,646,000	7,788,000	2,400,000	9,920,000
Value	$43,387	$41,569	$74,120	$29,900	$100,140
Average per M	$10.57	$8.95	$9.52	$12.46	$10.09
Fancy or ornamental . value	(a)	(a)	(a)	(a)	
Fire ... do			(a)		
Draintile ... do	$49,832	$74,702	$95,899	$64,391	$58,547
Fireproofing ... do	$1,595	(a)	(a)		(a)
Tile, not drain ... do		(a)			
Pottery:					
Earthenware ... do	$8,832	$9,300	$9,109	$8,965	$8,60
Stoneware ... do			(a)		
Miscellaneous ... do	$4,651	$2,575	$4,229	$2,170	$5,02
Total value	$1,127,819	$958,395	$1,139,589	$1,176,883	$1,158,13
Number of operating firms reporting	138	121	106	112	10
Rank of State	26	24	27	26	2

a Included in "Miscellaneous."

CLAY.

INTRODUCTION.

Clay available for the manufacture of clay products is one of the most widely spread of our minerals. Hence, there are clay-working plants scattered over every State and Territory in the Union. Clay miners are usually also the manufacturers of the lower-grade clays, but as the higher grades of ware are reached, the rule is that fewer and fewer manufacturers are also miners, until in the highest grades of ware the rule is that the manufacturer is not the miner of the clays that he uses. The figures given in the following tables represent clay that is mined and not manufactured by the miner, but is sold as clay. The clay thus sold is small in quantity compared with that consumed and includes mainly clay used for high-grade pottery, for paper making, and for refractory products.

The clay-mining industry in 1911, in common with the clay-working industries, showed a decrease. Every variety of clay except one showed a decrease in quantity of clay marketed, and but two varieties showed increases in value, and these were comparatively small, so that on the whole the industry was not as prosperous as it was in 1910, though the quantity and value of the clay marketed were greater than those of 1909, when the industry was in a progressive condition. The remarkable increase in production and value of clay in Kentucky was the most noteworthy feature of the year. The production of kaolin is apparently on the decrease in the United States, while paper clay is on the increase. This condition may be more apparent than real. The line of demarcation between these two varieties of clay is so uncertain that it may be that these clays in this report have not been correctly classified. Only white-burning residual clays are included in "kaolin" in these reports. The average price per ton for five of the varieties of clay increased and for two it decreased, while the general average price increased 7 cents per ton.

PRODUCTION.

The following table shows the production of clay in 1910 and 1911 by varieties:

Production of clay in the United States in 1910 and 1911, by kinds, in short tons.

Variety.	1910			1911		
	Quantity.	Value.	Average price per ton.	Quantity.	Value.	Average price per ton.
Kaolin	34,221	$255,873	$7.48	27,400	$221,045	$8.07
Paper clay	85,949	420,476	4.89	99,265	454,435	4.58
Slip clay	17,696	29,962	1.69	8,393	16,770	2.00
Ball clay	70,637	257,265	3.64	65,072	220,710	3.39
Fire clay	1,638,931	2,157,720	1.32	1,526,921	2,112,827	1.38
Stoneware clay	152,942	153,044	1.00	151,384	165,751	1.09
Brick clay	173,625	128,039	.74	142,020	123,900	.87
Miscellaneous	215,228	223,106	1.04	162,243	165,325	1.02
Total	2,389,229	3,625,485	1.52	2,182,698	3,480,763	1.59

This table shows that the total quantity of clay mined and sold as such in 1911 was 2,182,698 short tons, as compared with 2,389,229 short tons in 1910, a decrease of 206,531 tons, or 8.64 per cent. The value of the clay mined in 1911 was $3,480,763, or $1.59 per ton, as compared with $3,625,485, or $1.52 per ton, in 1910. This was a decrease of $144,722, or 3.99 per cent. Every variety, except paper clay, showed a decrease in quantity, and every one showed a decrease in value except paper clay and stoneware clay. Fire clay showed the largest decrease in quantity, 112,010 tons, or 6.83 per cent. Paper clay showed an increase of 13,316 tons, or 15.49 per cent. Except for the miscellaneous varieties, fire clay showed the largest decrease in value, $44,893, or 2.08 per cent. Fire clay was the principal variety, being 69.96 per cent of the quantity and 60.70 per cent of the value of all clay marketed as such in 1911. The average price per ton increased for kaolin 59 cents, for slip clay 31 cents, for fire clay 6 cents, for stoneware clay 9 cents, and for brick clay 13 cents. The general average increased 7 cents per ton over the average for 1910.

The following table shows the production and value of clay in the United States from 1905 to 1911, inclusive:

Clay mined and sold in the United States, 1905–1911, in short tons.

Year.	Kaolin.		Paper clay.		Slip clay.		Ball clay.		Fire clay.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
1905	44,675	$326,835	76,339	$307,238	24,565	$33,384	61,345	$167,212	1,229,647	$1,529,468
1906	51,937	369,452	75,963	342,708	21,427	31,546	54,173	199,073	1,380,472	1,878,011
1907	47,645	340,311	66,191	293,943	20,325	37,925	52,413	195,515	1,474,462	2,054,698
1908	28,649	216,243	64,510	310,943	10,087	22,370	40,838	133,770	1,101,579	1,486,139
1909	31,227	241,060	81,586	386,764	18,010	30,527	49,074	214,194	1,463,919	2,082,193
1910	34,221	255,873	85,949	420,476	17,696	29,962	70,637	257,265	1,638,931	2,157,720
1911	27,400	221,045	99,265	454,435	8,393	16,770	65,072	220,710	1,526,921	2,112,827

Year.	Stoneware clay.		Brick clay.[a]		Miscellaneous clay.		Total.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
1905	181,485	$219,767	....	....	188,077	$184,102	1,806,133	$2,768,006
1906	146,861	150,774	....	....	296,619	273,692	2,027,452	3,245,256
1907	125,060	136,576	136,515	$112,003	261,068	277,577	2,183,679	3,448,548
1908	124,192	102,390	210,556	154,575	143,490	173,556	1,723,901	2,599,986
1909	130,757	137,264	222,686	171,183	162,388	186,522	2,159,647	3,449,707
1910	152,942	153,044	173,625	128,039	215,228	223,106	2,389,229	3,625,485
1911	151,384	165,751	142,020	123,900	162,243	165,325	2,182,698	3,480,763

[a] Included in miscellaneous in 1905 and 1906.

This table shows that the quantity of clay mined in the period covered has risen steadily, except in 1908 and 1911, from 1,806,133 short tons in 1905 to 2,389,229 short tons in 1910, with a slight decrease in 1911. From 1905 to 1911 the quantity of clay mined increased 376,565 tons, or 20.85 per cent, and the value increased $712,757, or 25.75 per cent. From 1905 to 1910, the year of maximum quantity and value, the increase in quantity was 583,096 tons, or 32.28 per cent, and in value it was $857,479 or 30.98 per cent. Kaolin reached its maximum quantity and value in 1906, and its minimum quantity in 1911 and its minimum value in 1908. Paper clay reached its maximum quantity and value in 1911. Slip clay showed its maximum quantity in 1905 and its maximum value in 1907; it reached its minimum quantity and value in 1911. Ball clay reached its maximum quantity and value in 1910 as did fire clay.

Clay mined and sold in the United States in 1910, by States, in short tons.

State.	Kaolin.		Paper clay.		Slip clay.		Ball clay.		Fire clay.		Stoneware clay.		Brick clay.		Miscellaneous clay.[a]		Total.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value	Quantity.	Value.	Quantity.	Value.
Alabama									54,482	$32,395			(b)	(b)	17,600	$3,700	75,082	$38,045
Arizona [c]	(b)	(b)							642	4,030	(b)	(b)	(b)	(b)	805	805	15,595	124,035
California									39,104	63,829	8,341	$5,925	(b)	(b)	14,880	21,234	70,465	104,163
Colorado									29,410	31,467			61,402	$40,883	15,062	11,505	105,874	83,855
Delaware	(b)	(b)							(b)	(b)							11,117	60,744
Florida							27,400	$134,512	(b)	(b)							27,403	134,542
Georgia			36,571	$184,529					7,821	6,031	2,879	8,656			19,021	24,569	66,292	223,785
Illinois									82,878	111,078	42,410	34,202	13,704	16,344	49,811	29,272	188,803	190,896
Indiana					(b)	(b)			77,525	69,184	3,232	4,025	(b)	(b)	3,799	4,450	88,176	80,829
Iowa									(b)	(b)			(b)	(b)	700	210	12,640	5,153
Kentucky					(b)	(b)	(b)	(b)	60,342	45,962	(b)	(b)	728	401	(b)	(b)	80,420	85,655
Maryland	(b)	(b)							17,490	31,024	2,100	2,650	1,150	1,125	256	344	22,696	46,143
Massachusetts									931	1,911	(b)	(b)	(b)	(b)			1,922	2,985
Michigan					1,363	$3,889							(b)	(b)	(b)	(b)	1,424	4,394
Missouri	(b)	(b)							282,834	488,365	1,246	1,294	(b)	(b)	439	466	287,445	509,433
Montana									7,011	10,069							7,011	10,069
New Jersey							(b)	(b)	286,854	468,890	21,099	45,171	30,645	28,683	64,097	97,685	405,591	657,805
New Mexico									14,235	30,727							14,235	30,727
New York					(b)	(b)			(b)	(b)					1,424	1,561	5,880	13,241
Ohio					(b)	(b)			231,568	172,162	57,087	39,307	(b)	(b)	4,700	5,257	325,308	228,255
Pennsylvania	4,303	$23,411	20,327	117,021					345,388	478,619	9,066	5,760	6,499	5,025	10,655	6,777	396,238	636,613
South Carolina			29,051	118,920					(b)	(b)					210	181	29,920	122,567
Tennessee							32,344	82,994	17,122	24,454	4,913	5,578			7,028	7,727	61,407	120,753
Texas									1,114	5,786							1,114	5,786
Utah									6,209	8,903							6,209	8,903
Vermont	5,900	33,200							(b)	(b)					(b)	(b)	6,060	34,038
Virginia									499	1,475					31	11	530	1,486
Washington									3,451	5,932					400	1,200	3,851	7,132
West Virginia									65,335	47,623			(b)	(b)	3,695	3,620	69,630	51,543
Wisconsin											(b)	(b)	(b)	(b)	50	100	359	518
Wyoming															532	1,392	532	1,392
Other States [d]	24,018	199,262			16,333	26,073	10,893	39,759	6,686	17,804	569	476	59,497	35,578	33	1,040	(e)	(e)
Total	34,221	255,873	85,949	420,476	17,696	29,962	70,637	257,265	1,638,931	2,157,720	152,942	153,044	173,625	128,039	215,228	223,106	2,389,229	3,625,485

[a] Including bentonite, modeling clay, pipe clay, terra-cotta clay, and clay for medicinal use.
[b] Included in "Other States."
[c] Including Connecticut, Idaho, Minnesota, Mississippi, North Carolina, North Dakota, and Oregon.
[d] Includes all products which could not be published separately without disclosing individual figures.
[e] The total of "Other States" is distributed among the States to which it belongs in order that they may be fully represented in the totals.

Clay mined and sold in the United States in 1911, by States, in short tons.

State.	Kaolin.		Paper clay.		Slip clay.		Ball clay.		Fire clay.		Stoneware clay.		Brick clay.		Miscellaneous clay.[a]		Total.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Alabama									35,203	$29,909							35,203	$29,909
California									48,264	63,000	21,795	$20,100	16,918	$28,847	279	$369	87,256	112,316
Colorado									82,729	68,593	(b)	(b)	10,848	13,260			95,127	83,636
Delaware	(b)	(b)							(b)	(b)							7,950	46,024
Florida							24,167	$114,751									24,167	114,751
Georgia			45,076	$199,135					11,363	8,866			(b)	(b)	11,655	15,261	68,161	223,462
Idaho[c]	(d)	(d)							171	1,328					569	1,075	7,425	46,792
Illinois									71,479	91,623	30,402	29,473	(b)	(b)	64,155	37,530	182,836	183,826
Indiana									59,611	53,377	675	749			1,706	792	61,992	54,918
Iowa									(b)	(b)			(b)	(b)			9,643	3,965
Kentucky							(b)	(b)	117,745	98,796			(b)	(b)	352	612	131,808	126,457
Maryland	(b)	(b)	(e)	(e)					6,763	17,079	(b)	(b)	1,150	1,050	[e]1,410	[e]2,044	12,323	28,123
Massachusetts									(b)	(b)	(b)	(b)	(b)	(b)			1,187	2,972
Michigan					1,744	$5,090							(b)	(b)	(b)	(b)	1,764	5,272
Missouri	139	$1,270							215,468	498,179	(b)	(b)	(b)	(b)	(b)	(b)	227,691	512,088
Montana									3,571	8,946			(b)	(b)			4,912	9,617
New Jersey							(b)	(b)	282,777	471,695	29,392	64,068	32,040	20,326	60,454	96,353	405,912	658,875
New Mexico									8,514	12,800							8,514	12,800
New York					(b)	(b)			(b)	(b)			(b)	(b)	1,262	677	4,882	10,308
North Carolina	14,822	130,554									81	56					14,903	130,610
Ohio					(b)	(b)			197,324	154,816	51,460	33,592	31,150	10,872	2,601	2,488	285,735	206,668
Oregon									730	6,637	(b)	(b)			(b)	(b)	1,283	7,053
Pennsylvania			23,549	135,288					281,212	411,884	3,802	2,820	14,230	13,789	6,404	3,841	329,197	567,622
South Carolina			30,640	120,012					(b)	(b)					200	399	31,585	124,063
Tennessee							29,896	74,326	19,000	29,793	(b)	(b)					49,653	104,277
Texas									2,068	9,460					(b)	(b)	2,070	9,480
Utah									3,776	9,241							3,776	9,241
Virginia									(b)	(b)					(b)	(b)	10,666	3,087
Washington					(b)	(b)			(b)	(b)			(b)	(b)			1,187	2,753
West Virginia									71,704	47,776			(b)	(b)			73,304	48,576
Wisconsin											(b)	(b)	(b)	(b)	(b)	(b)	586	1,222
Other States[f]	12,439	89,221			6,649	11,680	11,009	31,633	6,849	19,029	13,777	14,893	35,684	35,756	11,196	3,884	(g)	(g)
Total	27,400	221,045	99,265	454,435	8,393	16,770	65,072	220,710	1,526,921	2,112,827	151,384	165,751	142,020	123,900	162,243	165,325	2,182,698	3,480,763

[a] Including bentonite, modeling clay, pipe clay, terra-cotta clay, and clay for medicinal use.
[b] Included in "Other States."
[c] Including North Dakota, Vermont, and Wyoming.
[d] Produced by Vermont alone, and included in "Other States."
[e] Paper clay for Maryland is included in "Maryland miscellaneous."
[f] Includes all products which could not be published separately without disclosing individual figures.
[g] The total of "Other States" is distributed among the States to which it belongs in order that they may be fully represented in the totals.

The leading clay-producing State in 1911, as for several preceding years, in both quantity and value, was New Jersey. In 1911 the output and value in this State were practically the same as in 1910, there being an increase in quantity of clay mined of 321 tons and in value of $1,070. For 1911 New Jersey reported 18.60 per cent of the total quantity of clay produced and 18.93 per cent of the total value. For 1910 these percentages were 16.98 and 18.14, respectively. Of New Jersey's total clay production fire clay was 69.66 per cent of the quantity and 71.59 per cent of the value. Pennsylvania was the second State in production and value of clay mined in 1911, as for several years, and reported 15.08 per cent of the total clay produced in the country and 16.31 per cent of the value. There was a decrease in the quantity of clay mined in Pennsylvania in 1911 of 67,041 tons and a decrease in value of $68,991. In this State fire clay was also the leading variety, 85.42 per cent of quantity of the clay mined in the State and 72.56 per cent of the value being of this variety.

Ohio, the leading clay-working State, was third in quantity of clay marketed and fifth in value, and Missouri was fourth in quantity and third in value. Ohio showed a decrease in quantity of clay mined of 39,573 tons, or 12.16 per cent, and of $21,587, or 9.46 per cent, in value. Missouri's output of clay decreased 59,754 tons, or 20.79 per cent, while the value of its clay increased $2,655, or 0.52 per cent. These four States, New Jersey, Pennsylvania, Ohio, and Missouri, reported 1,248,535 tons of clay in 1911, or 57.20 per cent of the total quantity, and the value of this clay was $1,945,253, or 55.89 per cent of the total.

Of 26 other States reporting production of clay in 1911, there were 8 that reported increases in both quantity and value, 16 that reported decreases in both, and 2, Georgia and West Virginia, that reported increases in quantity and decreases in value, and 2, Missouri and Utah, that reported decreases in quantity and increases in value. Of the States reporting increases, Kentucky showed the largest increase, 51,388 tons, or 63.90 per cent, and $40,802, or 47.64 per cent. This increase was almost entirely in fire clay. New Jersey was first in output of fire clay, though second in value. Pennsylvania, which was first in production and second in value of fire clay in 1910, was second in production and third in value in 1911. Missouri was third in production and first in value, as in 1910; Ohio was fourth in both quantity and value in 1910 and 1911; Kentucky was fifth in both quantity and value in 1911. The average price per ton of fire clay in these States in 1911 was : Kentucky, $0.84; Missouri, $2.31; New Jersey, $1.67; Ohio, $0.78; and Pennsylvania, $1.46. In 1910 these prices of fire clay were $0.76, $1.73, $1.63, $0.74, and $1.39, repsectively. These five States produced 1,094,526 tons, or 71.68 per cent of the total quantity of fire clay, valued at $1,635,370, or 77.40 per cent of the total value of fire clay in 1911.

IMPORTS.

The following table shows the imports of clay from 1907 to 1911:

Classified imports of clay for consumption, 1907–1911, in short tons.

Year.	Kaolin or china clay.			All other clays.						Total.	
				Unwrought.		Wrought.		Common blue.			
	Quantity.	Value.	Average value per ton.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
1907	239,923	$1,582,893	$6.60	31,196	$145,698	2,520	$81,156	12,378	$110,686	286,017	$1 920,432
1908	176,895	1,129,847	6.39	27,730	129,411	1,372	22,990	4,872	37,053	219,869	1,319,301
1909	246,381	1,505,779	6.11	30,147	134,978	1,906	50,632	12,346	104,401	290,780	1,795,790
1910	257,902	1,593,472	6.18	27,890	113,352	1,496	26,205	21,176	181,334	308,464	1,914,363
1911	255,107	1,461,068	5.73	26,086	100,540	1,032	10,436	17,193	124,278	299,418	1,696,322

The imports of clay, except of kaolin or china clay and the clay designated as common blue but which is high-grade fire clay, are unimportant. In 1911 of the clay imported, 85.20 per cent of the quantity and 86.13 per cent of the value, was kaolin or china clay.

The total quantity of clay imported in 1911 decreased 9,046 tons, or 2.93 per cent, and the total value decreased $218,041, or 11.39 per cent. Every variety of clay imported decreased in both quantity and value in 1911. The largest decrease in quantity was 3,983 tons in the blue clay, and the largest decrease in value was $132,404 in kaolin. The average price per ton for kaolin in 1911 was $5.73, as compared with $6.18 in 1910.

BUILDING OPERATIONS.

The following tables show the building operations of some of the leading cities of the country. Efforts were made to obtain detailed information for all cities of 35,000 or more inhabitants—157 in number. For 108 cities sufficient detail was received to include these cities in a table, for 37 cities only the totals for permits and cost of buildings could be obtained, and for 12 cities data were not procured.

The first table shows a comparison between 1910 and 1911 in 51 cities, also the increase or decrease in the cost of building operations. Used as an index of prosperity the figures here given show that the building industries were not as prosperous as in 1910 or 1909. Where an exact comparison can be made, there was a decrease in 1911 of 4.48 per cent from 1910 and of 9.16 per cent from 1909.

Building operations in a number of the leading cities of the United States in 1910 and 1911.

City.	1910		1911		Increase (+) or decrease (−) in 1911.	Percentage of increase or decrease in 1911.	Rank of cities in cost of buildings in 1911.
	Number of permits or buildings.	Cost.	Number of permits or buildings.	Cost.			
Atlanta, Ga	4,001	$6,645,167	3,993	$6,142,077	− $503,090	− 7.57	26
Baltimore, Md	2,841	11,771,680	a 2,150	a 8,901,198	− 2,870,482	−24.38	21
Boston, Mass	3,608	20,869,671	3,547	19,379,396	− 1,490,275	− 7.14	7
Brooklyn, N. Y	9,892	39,233,098	9,223	37,218,384	− 2,014,714	− 5.14	4
Buffalo, N. Y	3,494	9,232,000	3,402	10,364,000	+ 1,132,000	+12.26	19
Cambridge, Mass	389	2,339,900	567	2,905,525	+ 565,625	+24.17	41
Chicago, Ill	23,255	101,098,700	12,586	103,272,000	+ 2,173,300	+ 2.15	2
Cincinnati, Ohio	4,050	8,052,870	11,228	12,688,540	+ 4,635,670	+57.57	15
Cleveland, Ohio	7,460	13,948,413	7,860	16,994,677	+ 3,046,264	+21.84	11
Columbus, Ohio	2,363	5,133,591	2,694	4,668,277	− 465,314	− 9.06	38
Dayton, Ohio	1,082	2,015,000	993	2,339,390	+ 324,390	+16.10	45
Denver, Colo	2,683	11,319,955	2,410	6,084,260	− 5,235,695	−46.25	27
Detroit, Mich	5,498	17,415,950	6,667	19,012,670	+ 1,596,720	+ 9.17	9
Fall River, Mass	469	1,544,129	496	2,706,575	+ 1,162,446	+75.28	42
Grand Rapids, Mich	1,268	2,255,621	1,312	2,520,296	+ 264,675	+11.73	44
Hartford, Conn	1,053	4,541,979	1,305	5,896,244	+ 1,354,265	+29.82	29
Indianapolis, Ind	5,112	8,194,311	4,941	8,349,477	+ 155,166	+ 1.89	22
Jersey City, N. J	1,522	6,932,570	2,012	5,506,342	− 1,426,228	−20.57	34
Kansas City, Kans	800	1,101,356	639	867,702	− 233,654	−21.22	51
Kansas City, Mo	3,147	12,819,690	3,736	12,818,103	− 1,587	− .01	14
Los Angeles, Cal	10,738	21,684,100	12,498	23,004,185	+ 1,320,085	+ 6.09	5
Louisville, Ky	2,468	3,996,792	2,447	5,625,527	+ 1,628,735	+40.75	32
Lowell, Mass	562	1,777,654	564	1,500,269	− 277,385	−15.60	47
Memphis, Tenn	3,419	6,280,498	3,213	5,859,146	− 421,352	− 6.71	31
Milwaukee, Wis	4,086	9,797,580	4,360	12,299,375	+ 2,501,795	+25.53	16
Minneapolis, Minn	6,225	14,363,830	6,026	13,735,285	− 628,545	− 4.38	13
Nashville, Tenn	2,010	1,541,945	1,515	1,499,408	− 42,537	− 2.76	48
Newark, N. J	3,001	13,394,812	a 2,460	a 10,975,334	− 2,419,478	−18.06	18
New Bedford, Mass	1,179	7,037,337	950	2,601,150	− 4,436,187	−63.04	43
New Haven, Conn	1,035	4,386,065	1,196	5,868,519	+ 1,482,454	+33.80	30
New Orleans, La	2,530	4,483,730	b 2,282	b 3,155,150	− 1,328,580	−29.63	40
New York, N. Y	6,877	154,075,625	6,496	135,703,715	−18,371,910	−11.92	1
Oakland, Cal	3,968	6,913,643	3,946	7,132,566	+ 218,923	+ 3.17	24
Omaha, Nebr	1,533	6,250,988	1,372	5,426,863	− 824,125	−13.18	35
Philadelphia, Pa	16,383	37,866,565	16,215	40,030,985	+ 2,164,420	+ 5.72	3
Pittsburgh, Pa	3,903	12,753,664	4,392	11,963,257	− 790,407	− 6.20	17
Portland, Oreg	6,523	20,886,202	7,686	19,152,370	− 1,733,832	− 8.30	8
Providence, R. I	2,306	4,935,300	2,755	5,524,200	+ 588,900	+11.93	33
Reading, Pa	411	1,054,555	410	1,072,825	+ 18,270	+ 1.73	49
Richmond, Va	1,397	4,012,822	1,528	6,018,699	+ 2,005,877	+49.99	28
Rochester, N. Y	3,456	10,082,528	3,680	9,389,775	− 692,753	− 6.87	20
St. Joseph, Mo	772	1,129,931	648	995,473	− 134,458	−11.90	50
St. Louis, Mo	9,419	19,600,063	8,152	18,607,556	− 992,507	− 5.06	10
St. Paul, Minn	3,809	10,053,006	2,033	6,909,240	− 3,143,766	−31.27	25
San Francisco, Cal	5,690	20,508,556	6,079	20,915,474	+ 406,918	+ 1.98	6
Scranton, Pa	894	2,085,948	787	1,969,454	− 116,494	− 5.58	46
Seattle, Wash	13,082	17,418,078	10,959	7,491,156	− 9,926,922	−56.99	23
Syracuse, N. Y	1,701	5,019,032	1,698	5,238,184	+ 219,152	+ 4.37	36
Toledo, Ohio	1,732	4,058,188	1,793	3,722,536	− 335,652	− 8.27	39
Washington, D. C	5,847	16,278,658	4,678	14,464,548	− 1,814,110	−11.14	12
Worcester, Mass	1,514	3,919,652	1,545	4,716,163	+ 796,511	+20.32	37
Total	212,457	734,112,998	206,124	701,203,520	−32,909,478	− 4.48	....

[a] Figures supplied by the Bureau of Statistics, Department of Commerce and Labor. The number of permits or buildings was estimated.

[b] Public buildings were not included.

Of the 51 cities included in this table, 28 showed decrease and 23 showed increase. The total increase was $29,762,561; the total decrease was $62,672,039, a net decrease of $32,909,478, or 4.48 per cent. In 1910 of these cities 29 showed increase and 22 showed decrease, the net decrease for that year being $37,824,566, or 4.90 per cent. Compared with 1909 there was a decrease of $70,734,044, or 9.16 per cent. The greatest decrease in 1911 was in New York City, $18,371,910, or 11.92 per cent. The greatest proportional decrease in 1911 was in New Bedford, Mass., 63.04 per cent. The city to show the second largest decrease in cost of buildings was Seattle, Wash., $9,926,922, or 56.99 per cent. These two cities contributed 45.15 per cent of the total decrease. The largest increase was in Cincinnati, Ohio, $4,635,670, or 57.57 per cent. The largest proportional increase was in Fall River, Mass., where the building operations cost $1,162,446, or 75.28 per cent more than those of 1910.

Of these 51 cities 16 showed increase in both 1910 and 1911 and 15 showed decrease in both years.

Thirteen cities, Atlanta, Baltimore, Boston, Columbus, Jersey City, Lowell, Memphis, Minneapolis, New Bedford, Portland, Oreg., Rochester, Toledo, and Washington showed increase in 1910 and decrease in 1911. Seven cities, Buffalo, Grand Rapids, Milwaukee, Philadelphia, Providence, San Francisco, and Worcester, which showed decrease in 1910 showed increase in 1911, four of them, Buffalo Milwaukee, Providence, and Worcester, exceeding in 1911 the cost of building operations in 1909.

The total number of permits or buildings decreased from 212,457 in 1910 to 206,124 in 1911, a decrease of 6,333, or 2.98 per cent. In 1910 there was a decrease of 1,041, or 0.49 per cent. The number of permits ranged in 1911 from 410 in Reading to 16,215 in Philadelphia. The average cost of operations in these 51 cities in 1911 was $3,402 per building or permit; in 1910 it was $3,455; and in 1909 it was $3,616. In New York the average cost was $20,890 in 1911, $22,404 in 1910, and $24,387 in 1909. In Chicago the average cost was $8,205 in 1911, $4,374 in 1910, and $4,341 in 1909. In Philadelphia, the third largest city in cost of building operations in 1911, the average cost was $2,469; in 1910 it was $2,311, and $2,480 in 1909. In Brooklyn the average cost was $4,035 in 1911, $3,966 in 1910, and $4,672 in 1909.

These 51 cities reported 81.16 per cent of the total cost of the building operations of the 145 cities given on the following pages.

The following table shows the building operations in 145 of the larger cities of the country. Figures are given in such detail as could be furnished by the various city officials, showing the varieties of buildings erected and additions, alterations, and repairs to each class of buildings. These figures by kinds of buildings are of course not exact, but it is believed that for wooden buildings and for the more substantially constructed buildings, designated in these tables as fire-resisting, the figures are substantially correct. For 37 cities it is possible to give only the totals for permits or buildings, and for the cost of all building operations.

Building statistics of the leading cities of the United States, by character of operations, in 1911.

City.	Wooden buildings.						Fire-resisting buildings.							
							Brick.				Stone.			
	New.		Additions, alterations, and repairs.		Total.		New.		Additions, alterations, and repairs.		New.		Additions, alterations, and repairs.	
	Number of permits or buildings.	Cost.	Number of permits or buildings.	Cost.	Number of permits or buildings.	Cost.	Number of permits or buildings.	Cost.	Number of permits or buildings.	Cost.	Number of permits or buildings.	Cost.	Number of permits or buildings.	Cost.
Akron, Ohio	1,363	$1,793,224	384	$134,363	1,747	$2,107,587	189	$2,061,726	30	$37,015	....	....	....	....
Allentown, Pa	64	39,700	22	5,700	86	45,400	523	1,534,400	66	69,750	4	$98,000	1	$16,000
Altoona, Pa	160	351,211	534	142,518	694	493,729	15	93,068	10	36,219	....	....	....	....
Atlanta, Ga	1,267	3,098,094	*a* 2,631	*a* 987,556	*a* 3,898	*a* 4,085,650	83	1,116,617	(*a*)	(*a*)	....	....	....	....
Atlantic City, N. J	178	895,000	148	296,000	326	1,191,000	714	2,282,241	59	177,000	1	10,000	....	....
Augusta, Ga	153	161,485	*b* 1,127	*b* 79,354	1,280	240,839	15	284,715	(*b*)	(*b*)	....	....	....	....
Bayonne, N. J	384	1,380,304	114	132,244	498	1,512,548	57	553,461	30	7,550	1	154,000	....	....
Berkeley, Cal	484	1,430,500	191	121,450	675	1,551,950	13	161,000	1	2,500	....	....	....	....
Birmingham, Ala	1,377	1,813,594	1,283	279,383	2,660	2,092,977	118	624,923	173	91,837	....	....	....	....
Boston, Mass	1,053	4,920,253	1,069	693,494	2,122	5,613,747	220	6,188,050	1,097	3,830,524	3	46,000	13	51,500
Bridgeport, Conn	(*c*)	1,063,172	(*c*)	156,104	542	1,219,276	150	604,614	100	151,153	73	100,153	....	....
Brockton, Mass	290	916,730	186	195,555	476	1,112,285	3	160,000	6	61,200	1	14,000	....	....
Brooklyn, N. Y	1,628	4,204,100	2,166	1,229,731	3,794	5,433,831	*d* 3,660	*d* 28,394,140	*d* 1,769	*d* 3,390,413	....	....	....	....
Buffalo, N. Y	1,991	4,496,250	1,157	776,260	3,148	5,272,510	193	3,465,640	34	133,000	7	180,500	....	....
Cambridge, Mass	205	1,003,675	237	255,900	442	1,259,575	*e* 42	*e* 1,269,800	*e* 83	*e* 376,150	(*e*)	(*e*)	(*e*)	(*e*)
Camden, N. J	80	120,000	97	14,450	177	134,450	585	1,203,500	56	28,000	....	....	....	....
Canton, Ohio	503	732,820	114	45,625	617	778,445	68	673,350	20	85,900	1	500	1	40,000
Charleston, S. C	124	148,012	283	75,555	407	223,567	14	250,800	86	75,909	....	....	....	....
Chester, Pa	9	3,600	....	....	9	3,600	377	423,800	23	31,200	3	23,500	....	....

[a] Additions, etc., to all classes of buildings for Atlanta, Ga., Portland, Oreg., and Youngstown, Ohio, are included with additions to wooden buildings. The total number of permits only was given for Youngstown, Ohio.

[b] Additions, etc., to brick buildings for Augusta, Ga., and Covington, Ky., are included with additions to wooden buildings.

[c] The number of permits was not given for new wooden buildings and for additions, etc., to wooden buildings for Bridgeport, Conn., nor for additions to brick buildings for Peoria, Ill.

[d] All classes of new fire-resisting buildings for Brooklyn, N. Y., are included with new brick buildings and additions, etc., to all classes of fire-resisting buildings are included with additions to brick buildings.

[e] New stone and new concrete buildings for Cambridge, Mass., are included with new brick buildings, and additions etc., to stone and concrete buildings are included with additions to brick buildings.

Building statistics of the leading cities of the United States, by character of operations, in 1911—Continued.

City.	Wooden buildings.						Fire-resisting buildings.							
							Brick.				Stone.			
	New.		Additions, alterations, and repairs.		Total.		New.		Additions, alterations, and repairs.		New.		Additions, alterations, and repairs.	
	Number of permits or buildings.	Cost.	Number of permits or buildings.	Cost.	Number of permits or buildings.	Cost.	Number of permits or buildings.	Cost.	Number of permits or buildings.	Cost.	Number of permits or buildings.	Cost.	Number of permits or buildings.	Cost.
Chicago, Ill	2,240	$4,855,000	1,500	$370,000	3,740	$5,225,000	a 6,583	a$50,908,000	a 1,985	a$9,692,000	(a)	(a)	....	....
Cleveland, Ohio	2,859	4,929,923	b 4,233	b 1,591,054	7,092	6,520,977	b 768	b10,473,700	....	....	(b)	(b)	....	....
Covington, Ky	69	77,915	c 56	c 45,865	125	123,780	124	491,707	(c)	(c)	....	....	....	....
Dayton, Ohio	827	1,572,400	67	79,100	894	1,651,410	60	526,680	18	54,200	....	....	....	....
Denver, Colo	88	77,950	14	14,780	102	92,730	1,767	5,415,085	541	576,445	....	....	....	....
Des Moines, Iowa	448	511,248	95	80,500	543	591,748	214	760,000	50	15,000	2	$350,000	....	....
Detroit, Mich	4,756	9,528,560	879	538,935	5,635	10,067,495	677	5,501,800	314	928,805	....	....	....	....
Dubuque, Iowa	51	171,480	4	3,300	55	174,780	29	951,400	4	62,900	....	....	....	....
Duluth, Minn	720	1,007,575	468	204,499	1,188	1,212,074	84	688,767	96	196,497	....	....	....	....
Elizabeth, N. J	333	1,014,214	107	87,953	440	1,102,167	34	490,544	15	67,465	....	....	....	....
Elmira, N. Y	108	232,250	....	....	108	232,250	14	259,000	16	18,100	....	....	....	....
Erie, Pa	718	710,955	107	103,420	825	814,375	a 102	a 1,160,007	32	77,424	(a)	(a)	....	....
Evansville, Ind	594	638,931	512	77,818	1,106	716,749	89	673,118	133	191,378	....	....	....	....
Fall River, Mass	304	820,800	101	59,000	405	879,800	30	971,500	6	37,800	5	40,275	....	....
Fitchburg, Mass	155	410,856	111	92,544	266	503,400	10	165,500	9	63,450	1	8,000	....	....
Galveston, Tex	50	90,150	161	21,394	211	111,544	15	520,200	49	22,795	....	....	....	....
Grand Rapids, Mich	712	1,042,138	403	178,781	1,115	1,220,919	75	1,074,330	66	141,650	....	....	....	....
Harrisburg, Pa	37	36,425	45	26,275	82	62,700	332	953,350	95	185,975	....	....	....	....
Hartford, Conn	625	1,884,349	378	278,400	1,003	2,162,749	222	2,783,600	77	199,895	....	....	....	....
Haverhill, Mass	(d)	709,125	(d)	48,075	(d)	757,200	(d)	364,500	(d)	9,700	....	....	....	....
Hoboken, N. J	26	25,105	101	55,808	127	80,913	19	241,379	106	108,797	....	....	....	....
Holyoke, Mass	79	237,000	10	10,000	89	247,000	48	1,588,200	22	180,000	....	....	....	....
Houston, Tex	872	1,539,410	986	203,186	1,858	1,742,596	49	1,843,600	126	78,189	....	....	....	....
Indianapolis, Ind	1,629	3,635,650	2,380	778,489	4,009	4,414,139	87	695,700	....	....	....	....	....	....
Kalamazoo, Mich	295	800,000	40	20,000	335	820,000	20	400,000	15	50,000	2	50,000	....	....
Kansas City, Mo	1,539	4,026,001	1,500	475,552	3,039	4,501,553	348	3,068,761	279	340,643	22	297,900	5	$7,000
Knoxville, Tenn	97	179,964	509	85,020	606	264,984	28	381,524	340	73,348	....	....	....	....
Lawrence, Mass	183	763,075	110	147,430	293	910,505	13	397,850	20	156,430	....	....	....	....
Lincoln, Nebr	239	454,056	80	49,691	319	503,747	42	402,035	26	63,750	2	15,750	1	1,000
Little Rock, Ark	393	755,699	383	125,907	776	881,606	28	619,090	104	295,210	....	....	....	....
Los Angeles, Cal	**8,094**	**13,070,962**	**3,468**	**1,136,808**	**11,562**	**14,207,770**	**210**	**2,732,903**	**704**	**848,757**	....	....	....	....

Louisville, Ky	984	1,211,390	936	186,072	1,920	1,397,462	174	3,236,130	352	391,935				
Lowell, Mass	253	498,728	242	120,529	495	619,257	28	771,600	41	109,412				
Lynn, Mass	457	1,746,050	285	203,580	742	1,949,630	21	460,500	10	104,400				
McKeesport, Pa	39	64,238	24	14,365	63	78,603	10	80,219	3	8,600				
Manchester, N. H	326	905,387	256	220,334	582	1,125,721	7	159,200	12	19,160				
Milwaukee, Wis	1,962	5,412,575	2,015	1,061,139	3,977	6,473,714	288	2,183,005	23	404,143				
Minneapolis, Minn	3,409	5,356,470	1,874	786,055	5,283	6,142,525	132	1,004,280	340	640,325	5	54,700	12	16,610
Montgomery, Ala	123	165,007	130	41,293	253	206,300	17	191,853	58	45,081				
Nashville, Tenn	424	293,107	759	50,888	1,183	343,995	125	1,081,895	206	70,518	1	3,000		
New Bedford, Mass	499	1,891,150	418	300,000	917	2,191,150	22	250,000	11	160,000				
New Britain, Conn	80	334,400	231	83,865	311	418,265	58	636,150						
New Haven, Conn	549	1,863,913	377	153,121	926	2,017,034	176	2,904,361	79	171,724	3	655,500		
Newton, Mass	e 305	e 957,181	(e)	(e)	305	957,181	9	89,000			1	20,000		
New York, N. Y	278	659,536	319	383,130	597	1,042,666	1,613	41,512,069	3,510	8,992,626				
Norfolk, Va	254	530,106	99	42,518	353	572,624	266	1,434,411	53	59,575				
Oakland, Cal	2,149	4,301,237	1,712	744,441	3,861	5,045,678	31	1,620,951	11	33,365			1	300
Oklahoma City, Okla	789	1,170,941	42	34,400	831	1,205,341	145	1,537,138	37	85,777				
Passaic, N. J	211	598,250	112	74,380	323	672,630	70	777,348	50	66,105				
Paterson, N. J	(f)	(f)	(f)	(f)	f 813	f 1,237,636	150	933,511			5	53,000		
Pawtucket, R. I	185	585,390	120	64,425	305	649,8 5	8	54,775						
Peoria, Ill	297	883,021	271	140,451	568	1,023,472	49	599,292	(g)	142,528				
Philadelphia, Pa	22	42,810	59	8,620	81	51,430	9,360	28,242,245	4,325	5,508,475	26	52,540	30	10,415
Pittsburgh, Pa	1,282	3,987,752	1,050	1,425,278	2,332	5,413,030	922	3,623,178	525	827,053	25	125,000		
Portland, Oreg	4,486	9,183,139	h 2,912	h 2,074,085	7,398	11,257,224	184	2,368,696	(h)	(h)				
Pueblo, Colo	79	78,460	45	13,487	124	91,947	97	241,300	46	41,067				
Quincy, Ill	22	35,550	8	12,300	30	47,850	19	103,500	10	65,875	2	5,000		
Reading, Pa							186	572,350			109	436,000		
Richmond, Va	244	256,348	288	80,121	532	336,469	559	4,682,691	425	459,289				
Rochester, N. Y	2,219	5,875,939	921	505,051	3,140	6,380,990	112	1,506,472	220	524,323	1	90,000		
Sacramento, Cal	417	1,158,018	61	152,896	478	1,310,914	144	453,218	48	99,398				
Saginaw, Mich	211	211,805	63	27,190	274	238,995	21	244,450	17	36,350				
St. Paul, Minn	1,279	3,193,002	426	176,648	1,705	3,369,650	152	1,445,925	143	475,160				
Salem, Mass	197	629,530	141	126,822	338	756,352	3	4,800	4	56,000				
San Antonio, Tex	1,950	1,382,914	906	140,493	2,856	1,523,407	55	445,110	113	168,073				
San Francisco, Cal	2,514	8,345,956	3,015	698,825	5,529	9,044,781	287	8,145,673	176	420,000	14	1,809,097	26	300,000
Scranton, Pa	380	993,171	212	139,687	592	1,132,858	43	476,725	64	229,754				
Seattle, Wash	4,276	4,006,721	6,071	1,343,930	10,347	5,350,651	35	1,155,000	453	382,150				
Somerville, Mass	(f)	(f)	(f)	(f)	f 380	f 799,378	8	111,500	1	3,200	1	300		
South Bend, Ind	(f)	(f)	(f)	(f)	f 433	f 558,434	59	609,071						

[a] New stone buildings for Chicago, Ill., and Erie, Pa., are included with new brick buildings Additions, etc., to all classes of fire-resisting buildings for Chicago are included with additions to brick buildings.

[b] Additions, etc., to all classes of buildings for Cleveland, Ohio, are included with additions to wooden buildings and new stone buildings, and all other new fire-resisting buildings are included with new brick buildings.

[c] Additions, etc., to brick buildings for Augusta, Ga., and Covington, Ky., are included with additions to wooden buildings.

[d] The number of permits for Haverhill, Mass., was not given.

[e] Additions, etc., to wooden buildings for Newton, Mass., are included with new wooden buildings.

[f] The total only was given for wooden buildings for each of the following cities: Paterson, N. J., Somerville, Mass., South Bend, Ind., and Topeka, Kans. The percentage for these totals, equivalent to $\frac{45}{100}$ of 1 per cent, is included in the percentage for total wooden buildings.

[g] The number of permits was not given for new wooden buildings and for additions, etc., to wooden buildings for Bridgeport, Conn., nor for additions to brick buildings for Peoria, Ill.

[h] Additions, etc., to all classes of buildings for Atlanta, Ga., Portland, Oreg., and Youngstown, Ohio, are included with additions to wooden buildings. The total number of permits only was given for Youngstown, Ohio.

Building statistics of the leading cities of the United States, by character of operations, in 1911—Continued.

City.	Wooden buildings.						Fire-resisting buildings.							
							Brick.				Stone.			
	New.		Additions, alterations, and repairs.		Total.		New.		Additions, alterations, and repairs.		New.		Additions, alterations, and repairs.	
	Number of permits or buildings.	Cost.	Number of permits or buildings.	Cost.	Number of permits or buildings.	Cost.	Number of permits or buildings.	Cost.	Number of permits or buildings.	Cost.	Number of permits or buildings.	Cost.	Number of permits or buildings.	Cost.
Spokane, Wash	1,245	$1,499,030	259	$119,360	1,504	$1,618,390	91	$1,365,975	130	$320,440	3	$3,500	....	....
Springfield, Ill	242	544,770	140	88,085	382	632,855	45	578,600	52	112,895	1	200,000	....	....
Springfield, Mass	580	2,209,134	422	160,206	1,002	2,369,340	124	2,281,126	83	248,285	....	....	....	....
Syracuse, N. Y	947	3,043,986	585	435,898	1,532	3,479,884	60	1,112,350	62	346,925	1	74,000	....	....
Terre Haute, Ind	317	342,882	313	97,245	630	440,127	24	333,635	44	45,520	....	....	....	....
Tampa, Fla	764	588,600	350	42,300	1,114	630,900	142	655,235	37	10,243	25	15,054	....	....
Topeka, Kans	(a)	(a)	(a)	(a)	a 550	a 688,968	43	234,964	....	....	7	36,375	....	....
Troy, N. Y	76	248,350	144	72,190	220	320,540	40	340,700	132	374,460	....	....	....	....
Utica, N. Y	355	820,558	354	248,347	709	1,068,905	30	300,915	92	151,578	....	....	....	....
Washington, D. C	500	1,357,478	825	129,107	1,325	1,486,585	1,807	10,828,704	1,542	1,973,559	....	....	....	....
West Hoboken, N. J	46	58,350	52	76,235	98	134,585	46	267,532	....	....	....	....	....	....
Wheeling, W. Va	70	72,096	224	45,496	294	117,592	27	430,323	220	390,713	....	....	....	....
Wichita, Kans	326	619,575	34	29,490	360	649,065	34	463,000	14	19,000	3	83,000	....	....
Wilkes-Barre, Pa	363	772,303	145	179,977	508	952,280	101	838,987	52	136,840	....	....	....	....
Wilmington, Del	....	....	....	....	....	....	431	1,020,077	331	564,160	....	....	....	....
Worcester, Mass	873	2,692,966	....	....	873	2,692,966	b 79	b 1,043,285	b 593	b 979,912	....	....	....	....
Yonkers, N. Y	332	1,407,300	68	38,900	400	1,446,200	114	1,134,000	49	163,350	8	63,300	....	....
York, Pa	36	43,000	198	39,600	234	82,600	155	412,773	155	136,000	....	....	....	....
Youngstown, Ohio	(c)	1,302,837	(c)	c 115,191	(c)	1,418,028	(c)	1,830,265	(c)	(c)	....	....	....	....
Total	80,676	170,993,297	61,064	26,158,782	144,458	200,436,495	38,198	290,272,313	23,845	50,106,274	369	5,167,944	90	$442,825
Per cent of total	....	23.39	....	3.58	....	a 27.42	....	39.71	....	6.86	....	.71	....	.06

City.	Fire-resisting buildings.										Grand total.		Rank of cities in cost of buildings erected in 1911.
	Concrete.				All other.				Total.				
	New.		Additions, alterations, and repairs.		New.		Additions, alterations, and repairs.						
	Number of permits or buildings.	Cost.	Number of permits or buildings.	Cost.	Number of permits or buildings.	Cost.	Number of permits or buildings.	Cost.	Number of permits or buildings.	Cost.	Number of permits or buildings.	Cost.	
Akron, Ohio									219	$2,098,741	1,966	$4,206,328	43
Allentown, Pa	14	$21,600							608	1,739,750	694	1,785,150	86
Altoona, Pa									25	129,287	719	623,016	129
Atlanta, Ga	12	939,810		(c)					95	2,056,427	3,993	6,142,077	26
Atlantic City, N. J									774	2,469,241	1,100	3,660,241	45
Augusta, Ga									15	284,715	1,295	525,554	134
Bayonne, N. J									88	715,011	586	2,227,559	68
Berkeley, Cal	4	21,000					5	$3,000	23	187,500	698	1,739,450	87
Birmingham, Ala	5	4,385			4	$731,000	3	9,035	303	1,461,180	2,963	3,554,157	47
Boston, Mass	24	1,062,575	11	$15,900	24	1,977,850	33	593,250	1,425	13,765,649	3,547	19,379,396	7
Bridgeport, Conn	127	302,356					50	61,000	500	1,219,276	1,042	2,438,552	63
Brockton, Mass	2	3,750			3	38,995			15	277,945	491	1,390,230	100
Brooklyn, N. Y									5,429	31,784,553	9,223	37,218,384	4
Buffalo, N. Y	7	591,100			13	721,250			254	5,091,490	3,402	10,364,000	19
Cambridge, Mass	(d)	(d)	(d)	(d)					125	1,645,950	567	2,905,525	55
Camden, N. J					11	24,500			652	1,256,000	829	1,390,450	99
Canton, Ohio	3	17,000	2	3,525	17	36,400			112	856,675	729	1,635,120	90
Charleston, S. C									100	326,769	507	550,336	133
Chester, Pa	1	3,000			6	3,200	2	18,000	412	502,700	421	506,300	136
Chicago, Ill					278	37,447,000			8,846	98,047,000	12,586	103,272,000	2
Cleveland, Ohio					(e)	(e)			768	10,473,700	7,860	16,994,677	11
Covington, Ky									124	491,707	249	615,487	130
Dayton, Ohio	21	107,100							99	687,980	993	2,339,390	66

[a] The total only was given for wooden buildings for each of the following cities: Paterson, N. J., Somerville Mass., South Bend, Ind., and Topeka, Kans. The percentage for these totals, equivalent to $\frac{45}{100}$ of 1 per cent, is included in the percentage for total wooden buildings.

[b] All classes of new fire-resisting buildings for Worcester, Mass., are included with new brick buildings and additions, etc., to all classes of buildings are included with additions to brick buildings.

[c] Additions, etc., to all classes of buildings for Atlanta, Ga., Portland, Oreg., and Youngstown, Ohio, are included with additions to wooden buildings. The total number of permits only was given for Youngstown, Ohio.

[d] New stone and new concrete buildings for Cambridge, Mass., are included with new brick buildings, and additions etc., to stone and concrete buildings are included with additions to brick buildings.

[e] Additions, etc., to all classes of buildings for Cleveland, Ohio, are included with additions to wooden buildings and new stone buildings, and all other new fire-resisting buildings are included with new brick buildings.

Building statistics of the leading cities of the United States, by character of operations, in 1911—Continued.

City.	Fire-resisting buildings.										Grand total.		Rank of cities in cost of buildings erected in 1911.
	Concrete.				All other.				Total.				
	New.		Additions, alterations, and repairs.		New.		Additions, alterations, and repairs.						
	Number of permits or buildings.	Cost.	Number of permits or buildings.	Cost.	Number of permits or buildings.	Cost.	Number of permits or buildings.	Cost.	Number of permits or buildings.	Cost.	Number of permits or buildings.	Cost.	
Denver, Colo.									2,308	$5,991,530	2,410	$6,084,260	27
Des Moines, Iowa	3	$200,000					22	$10,000	291	1,335,000	834	1,926,748	81
Detroit, Mich.	19	1,706,395	5	$241,900	15	$486,025	2	80,250	1,032	8,945,175	6,667	19,012,670	9
Dubuque, Iowa	8	22,450							41	1,036,750	96	1,211,530	109
Duluth, Minn.	a 17	a 466,000	(a)	(a)	(a)	(a)	(a)	(a)	197	1,351,264	1,385	2,563,338	60
Elizabeth, N. J.	12	8,452			25	518,830			86	1,085,291	526	2,187,458	70
Elmira, N. Y.	8	125,400					1	43,000	39	445,500	147	677,750	127
Erie, Pa.									134	1,237,431	959	2,051,806	76
Evansville, Ind.	3	424,000							225	1,288,496	1,331	2,005,245	78
Fall River, Mass.	3	5,350			29	757,350	18	14,500	91	1,826,775	496	2,706,575	57
Fitchburg, Mass.	3	7,850							23	244,800	289	748,200	123
Galveston, Tex.	5	35,300					9	2,160	78	580,455	289	691,999	126
Grand Rapids, Mich.	55	82,797	1	600					197	1,299,377	1,312	2,520,296	62
Harrisburg, Pa.					8	47,050			435	1,186,375	517	1,249,075	105
Hartford, Conn.					3	750,000			302	3,733,495	1,305	5,896,244	29
Haverhill, Mass.	(b)	310,000			(b)	10,100			(b)	694,300	(b)	1,451,500	98
Hoboken, N. J.			1	950			4	9,350	130	360,476	257	441,389	138
Holyoke, Mass.									70	1,768,200	159	2,015,200	77
Houston, Tex.	5	614,000							180	2,535,789	2,038	4,278,385	42
Indianapolis, Ind.	64	748,295			42	1,744,478	739	746,865	932	3,935,338	4,941	8,349,477	22
Kalamazoo, Mich.	25	1,000,000	2	20,000					64	1,520,000	399	2,340,000	65
Kansas City, Mo.	25	427,900	3	37,000	8	4,113,000	7	15,346	697	8,316,550	3,736	12,818,103	14
Knoxville, Tenn.									368	454,872	974	719,856	124
Lawrence, Mass.	7	14,700	1	500					41	569,450	334	1,479,955	97
Lincoln, Nebr.	1	10,000	1	50	10	19,525			83	512,110	402	1,015,857	116
Little Rock, Ark.	1	500			2	160,000			135	1,074,800	911	1,956,406	80
Los Angeles, Cal.	16	1,132,755			6	4,082,000			936	8,796,415	12,498	23,004,185	5
Louisville, Ky.	1	600,000							527	4,228,065	2,447	5,625,527	33
Lowell, Mass.									69	881,012	564	1,500,269	93
Lynn, Mass.	5	9,300	2	300	2	24,000			40	598,500	782	2,548,130	61

McKeesport, Pa					6	1,925	2	1,400	21	92,144	84	170,747	145
Manchester, N. H	7	182,400			1	300			27	361,060	609	1,486,781	96
Milwaukee, Wis	23	1,422,500	3	29,800	23	1,382,070	23	404,143	383	5,825,661	4,360	12,299,375	16
Minneapolis, Minn	39	65,310	5	7,375	98	5,179,800	112	624,360	743	7,592,760	6,026	13,735,285	13
Montgomery, Ala									75	236,934	328	443,234	137
Nashville, Tenn									332	1,155,413	1,515	1,499,408	94
New Bedford, Mass									33	410,000	950	2,601,150	59
New Britain, Conn	1	45,000							59	681,150	370	1,099,415	113
New Haven, Conn	12	119,900							270	3,851,485	1,196	5,868,519	30
Newton, Mass	11	18,946			13	79,625	1	700	35	208,271	340	1,165,452	111
New York, N. Y					306	79,202,730	470	4,953,624	5,899	134,661,049	6,496	135,703,715	1
Norfolk, Va	1	32,000					31	19,096	351	1,545,082	704	2,117,706	73
Oakland, Cal	17	321,833	9	41,159	13	68,450	3	830	85	2,086,888	3,946	7,132,566	24
Oklahoma City, Okla									182	1,622,915	1,013	2,828,256	56
Passaic, N. J									120	843,453	443	1,516,083	92
Paterson, N. J	15	40,050							170	1,026,561	983	2,264,197	67
Pawtucket, R. I					7	12,650			15	67,425	320	717,240	125
Peoria, Ill	23	53,175			4	597,375			76	1,392,370	644	2,415,842	64
Philadelphia, Pa	46	4,860,900	10	742,500	38	9,260	2,299	553,220	16,134	39,979,555	16,215	40,030,985	3
Pittsburgh, Pa	33	66,000			45	50,000	510	1,858,996	2,060	6,550,227	4,392	11,963,257	17
Portland, Oreg	61	4,880,400	(c)	(c)	43	646,050			288	7,895,146	7,686	19,152,370	8
Pueblo, Colo									143	282,367	267	374,314	140
Quincy, Ill	2	6,000							33	180,375	63	228,225	143
Reading, Pa	26	52,000			89	12,475			410	1,072,825	410	1,072,825	114
Richmond, Va	11	535,250	1	5,000					996	5,682,230	1,528	6,018,699	28
Rochester, N. Y	96	202,716	55	27,566	48	647,129	8	10,579	540	3,008,785	3,680	9,389,775	20
Sacramento, Cal	15	1,223,462	1	400					208	1,776,478	686	3,087,392	53
Saginaw, Mich									38	280,800	312	519,795	135
St. Paul, Minn	33	1,618,505							328	3,539,590	2,033	6,909,240	25
Salem, Mass	4	9,800							11	70,600	349	826,952	122
San Antonio, Tex	12	31,850			61	54,300			241	699,333	3,097	2,222,740	69
San Francisco, Cal	15	1,010,500	32	185,423					550	11,870,693	6,079	20,915,474	6
Scranton, Pa					88	130,117			195	836,596	787	1,969,454	79
Seattle, Wash					20	540,245	104	63,110	612	2,140,505	10,959	7,491,156	23
Somerville, Mass	9	19,850			3	1,250			22	136,100	402	935,478	119
South Bend, Ind	39	73,675							98	683,346	531	1,241,780	106
Spokane, Wash	9	5,675	2	800					235	1,696,390	1,739	3,314,780	49
Springfield, Ill	1	40,000							99	931,495	481	1,564,350	91
Springfield, Mass									207	2,529,411	1,209	4,898,751	39
Syracuse, N. Y	38	221,125	5	3,900					166	1,758,300	1,698	5,238,184	38
Terre Haute, Ind	22	10,350							90	389,505	720	829,632	121
Tampa, Fla	22	160,200			4	25,423			230	866,155	1,344	1,497,055	95
Topeka, Kans	13	87,752							63	359,091	613	1,048,059	115
Troy, N. Y	4	32,300			9	751,600	3	27,500	188	1,526,560	408	1,847,100	84
Utica, N. Y	8	8,900	1	300	21	230,701	9	39,630	161	732,024	870	1,800,929	85

[a] All other new fire-resisting buildings for Duluth are included with new concrete buildings, and additions, etc., to concrete buildings and to all other fire-resisting buildings are included with new concrete buildings.

[b] The number of permits for Haverhill, Mass., was not given.

[c] Additions, etc., to all classes of buildings for Atlanta, Ga., Portland, Oreg., and Youngstown, Ohio, are included with additions to wooden buildings. The total number of permits only was given for Youngstown, Ohio.

Building statistics of the leading cities of the United States, by character of operations, in 1911—Continued.

City.	Fire-resisting buildings.										Grand total.		Rank of cities in cost of buildings erected in 1911.
	Concrete.				All other.				Total.				
	New.		Additions, alterations, and repairs.		New.		Additions, alterations, and repairs.						
	Number of permits or buildings.	Cost.	Number of permits or buildings.	Cost.	Number of permits or buildings.	Cost.	Number of permits or buildings.	Cost.	Number of permits or buildings.	Cost.	Number of permits or buildings.	Cost.	
Washington, D. C.	1	$700			3	$175,000			3,353	$12,977,963	4,678	$14,464,548	12
West Hoboken, N. J.									46	267,532	144	402,117	139
Wheeling, W. Va.	1	20,000	4	$915					252	841,951	546	959,543	118
Wichita, Kans.	4	43,500					26	$11,000	81	619,500	441	1,268,565	103
Wilkes-Barre, Pa.	11	161,445					17	14,725	181	1,151,997	689	2,104,277	75
Wilmington, Del.					5	593,600			767	2,177,837	767	2,177,837	71
Worcester, Mass.									672	2,023,197	1,545	4,716,163	40
Yonkers, N. Y.					23	113,750			194	1,474,400	594	2,920,600	54
York, Pa.									310	548,773	544	631,373	128
Youngstown, Ohio									(a)	1,830,265	1,130	3,248,293	50
Total	1,191	28,709,089	157	1,365,863	1,477	144,198,378	4,513	10,188,669	69,840	530,451,355	215,428	730,887,850	
Per cent of total		3.93		.19		19.73		1.39		72.58		100.00	
Albany, N. Y.											508	2,701,522	58
Baltimore, Md.											[b] 2,150	8,901,198	21
Bay City, Mich.											103	172,225	144
Butte, Mont.											146	276,100	142
Chattanooga, Tenn.											2,483	1,165,280	112
Cincinnati, Ohio.											11,228	12,688,540	15
Columbus, Ohio.											2,694	4,668,277	41
Dallas, Tex.											1,684	5,523,373	35
Davenport, Iowa.											255	1,212,015	108
El Paso, Tex.											619	1,182,780	110
Fort Wayne, Ind.											764	1,920,310	82
Fort Worth, Tex.											(b)	3,338,475	48
Jacksonville, Fla.											1,343	3,590,805	46
Jersey City, N. J.											2,012	5,506,342	36
Kansas City, Kans.											639	867,702	120
Lancaster, Pa.											641	1,302,424	102

Macon, Ga.	......	......	......	......	......	......	......	......	......	......	497	1,256,040	104
Memphis, Tenn.	......	......	......	......	......	......	......	......	......	......	3,213	5,859,146	31
Mobile, Ala.	......	......	......	......	......	......	......	......	......	......	([b])	353,226	141
Newark, N. J.	......	......	......	......	......	......	......	......	......	......	[b] 2,460	10,975,334	18
New Orleans, La.	......	......	......	......	......	......	......	......	......	......	[c] 2,282	[c] 3,155,150	52
Omaha, Nebr.	......	......	......	......	......	......	......	......	......	......	1,372	5,426,863	37
Portland, Me.	......	......	......	......	......	......	......	......	......	......	408	1,302,507	101
Providence, R. I.	......	......	......	......	......	......	......	......	......	......	2,755	5,524,200	34
St. Joseph, Mo.	......	......	......	......	......	......	......	......	......	......	648	995,473	117
St. Louis, Mo.	......	......	......	......	......	......	......	......	......	......	8,152	18,607,556	10
Salt Lake City, Utah	......	......	......	......	......	......	......	......	......	......	4,044	3,159,600	51
San Diego, Cal.	......	......	......	......	......	......	......	......	......	......	3,001	5,706,685	32
Savannah, Ga.	......	......	......	......	......	......	......	......	......	......	344	1,216,850	107
Schenectady, N. Y	......	......	......	......	......	......	......	......	......	......	([b])	1,898,933	83
Sioux City, Iowa	......	......	......	......	......	......	......	......	......	......	636	1,736,000	88
Springfield, Ohio	......	......	......	......	......	......	......	......	......	......	([b])	590,486	132
Superior, Wis.	......	......	......	......	......	......	......	......	......	......	208	612,935	131
Tacoma, Wash.	......	......	......	......	......	......	......	......	......	......	2,555	1,707,644	89
Toledo, Ohio.	......	......	......	......	......	......	......	......	......	......	1,793	3,722,536	44
Trenton, N. J.	......	......	......	......	......	......	......	......	......	......	1,287	2,145,828	72
Waterbury, Conn.	......	......	......	......	......	......	......	......	......	......	665	2,110,650	74
Grand total	......	......	......	......	......	......	......	......	......	......	279,017	863,968,860	......

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[a] Additions, etc., to all classes of buildings for Atlanta, Ga., Portland, Oreg., and Youngstown, Ohio, are included with additions to wooden buildings. The total number of permits only was given for Youngstown, Ohio.

[b] The number of permits or buildings was not given. The figures for Baltimore, Md., Mobile, Ala., and Newark, N. J., were supplied by the Bureau of Statistics, Department of Commerce and Labor. The number of permits or buildings for Baltimore and Newark have been estimated.

[c] Public buildings erected by the city of New Orleans are not included.

This table shows that the 145 cities included reported building operations costing $863,968,860. Of these, 108 cities reported sufficient detail to permit the publication of statistics of building operations by classes of structures. These 108 cities reported 215,428 permits or buildings, work on which cost $730,887,850. Of this cost, new buildings constituted 87.47 per cent, and additions, alterations, and repairs 12.08 per cent, 0.45 per cent of the total cost having been reported as wooden buildings unclassified.

Taken by classes, the new wooden buildings constituted 23.39 pe cent of the total cost, and additions, alterations, and repairs t wooden buildings, 3.58 per cent; new brick buildings, 39.71 per cent additions, etc., 6.86 per cent; new stone buildings, 0.71 per cent, additions, etc., 0.06 per cent; new concrete buildings, 3.93 per cent, additions, etc., 0.19 per cent; all other fire-resisting buildings, 19.73 pe cent, additions, etc., 1.39 per cent. Of the cost of new buildings 73.25 per cent was for fire-resisting buildings and 26.75 per cent fo wooden buildings. Of the cost of all new fire-resisting buildings, 61.9 per cent was for brick buildings, 1.10 per cent for stone buildings, 6.1 per cent for concrete buildings, and 30.79 per cent for all other fire-resisting buildings. Of the cost of additions, alterations, and repairs 29.64 per cent was for wooden buildings and 70.36 per cent for all fire-resisting buildings; of the fire-resisting buildings, 80.68 per cen was for brick buildings, 0.71 per cent for stone buildings, 2.20 pe cent for concrete buildings, and 16.41 per cent for all other fire-resisting buildings.

Operations on brick buildings (new buildings, additions, alterations, and repairs) constituted 46.57 per cent of the entire cost of al operations in these 108 cities, all other fire-resisting buildings contributing 26.01 per cent. In addition to the brick used in bric buildings large quantities of brick are used as foundations to woode buildings and in the construction of all other fire-resisting buildings though the use of fireproofing and hollow building tile or block i these buildings is increasing.

The average cost of new wooden buildings in the 108 cities shown i this table in 1911 was $2,120; of new brick buildings, $7,599; of ne stone buildings, $14,005; of new concrete buildings, $24,105; and miscellaneous fire-resisting buildings, $97,629.

Wooden buildings.—Los Angeles reported, as in 1910, the larges number of new wooden buildings, 8,094, with an average cost $1,615. This was an increase of 1,420 buildings over 1910. Th average cost per building decreased $138. Detroit, which was fourt in 1910, was second in 1911, reporting 4,756 new wooden buildings i 1911 at an average cost of $2,003. Seattle, which was second in 191 was fourth in 1911, and Portland, Oreg., was third in both years.

Los Angeles in 1911, as in 1910, was the leading city in the co of new wooden buildings, reporting a total cost of $13,070,962. Th was an increase of $1,375,638 over 1910. Detroit, which was fourt in 1910, was second in 1911, reporting new wooden buildings costin $9,528,560, an increase of $1,662,175 over 1910. Portland, Oreg was third in cost of this class of buildings in 1911, and San Francis fourth. In 1910 these cities were fifth and third, respectively.

Fire-resisting buildings.—New York City (the Boroughs of t Bronx and Manhattan) reported the greatest cost for fire-resistin buildings for 1911—$134,661,049, or 25.39 per cent of the total cost this class of buildings in these 108 cities; this was a decrease

$17,794,616, or 11.67 per cent from 1910. Chicago was second, as in 1910, with a cost of $98,047,000, or 18.48 per cent of the total. This was an increase over 1910 of $8,846,600, or 9.92 per cent. Philadelphia was third, reporting buildings costing $39,979,555, or 7.54 per cent of the total, which was an increase of $2,499,130, or 6.67 per cent over 1910. Brooklyn was fourth, as in 1910, reporting $31,784,553, or 5.99 per cent of the total. This was a decrease from 1910 of $1,519,905, or 4.56 per cent. Of the other leading cities that reported this class of buildings for 1911, the following showed decreases: Atlanta, $824,919, or 28.63 per cent, from 1910; Boston, $1,298,587, or 8.62 per cent; Denver, $5,216,450, or 46.54 per cent; Los Angeles, $245,018, or 2.71 per cent; Portland, Oreg., $4,661,089, or 37.12 per cent; St. Paul, $1,557,779, or 30.56 per cent; and Seattle, $8,241,799, or 79.38 per cent.

The following of the leading cities showed increases in this class of structures in 1911 over 1910: Buffalo, $985,040, or 23.99 per cent; Cleveland, $1,809,156, or 20.88 per cent; Hartford, $877,919, or 30.74 per cent; Kansas City, Mo., $604,050, or 7.83 per cent; Milwaukee, $2,197,241, or 60.56 per cent; New Haven, $1,140,491, or 42.07 per cent; Oakland, $245,972, or 13.36 per cent; Pittsburgh, $1,012,227, or 18.28 per cent; Richmond, $2,056,836, or 56.73 per cent; and San Francisco, $241,249, or 2.07 per cent.

SURVEY PUBLICATIONS ON CLAYS, FULLER'S EARTH, ETC.

In addition to the papers named below, certain of the geologic folios also contain references to clays, fuller's earth, etc.

These publications, except those to which a price is affixed or which are out of print, can be obtained free by applying to the Director, United States Geological Survey, Washington, D. C. The priced publications may be purchased from the Superintendent of Documents, Government Printing Office, Washington, D. C.

These reports may be examined in many public libraries.

Alden, W. C. Fuller's earth and brick clays near Clinton, Mass. In Bulletin 430, pp. 402–404. 1910.

Ashley, G. H. Notes on clays and shales in central Pennsylvania. In Bulletin 285, pp. 442–444. 1906. (Out of print.)

Ashley, H. E. The colloid matter of clay and its measurement. Bulletin 388. 65 pp. 1909.

Bastin, E. S. Clays of the Penobscot Bay region, Maine. In Bulletin 285, pp. 428–431. 1906. (Out of print.)

Branner, J. C. Bibliography of clays and the ceramic arts. Bulletin 143. 114 pp. 1896. (Out of print.)

——— The clays of Arkansas. Bulletin 351. 247 pp. 1908.

Butts, Charles. Clays of the Birmingham district, Alabama. In Bulletin 315, pp. 291–295. 1907. 50c.

Crider, A. F. Clays of western Kentucky and Tennessee. In Bulletin 285, pp. 417–427. 1906. (Out of print.)

Darton, N. H. Geology and water resources of the northern portion of the Black Hills and adjoining regions in South Dakota and Wyoming. Professional Paper 65. 106 pp. 1909.

Darton, N. H., and Siebenthal, C. E. Geology and mineral resources of the Laramie Basin, Wyoming; a preliminary report. Bulletin 364. 81 pp. 1909.

Deussen, Alexander. Notes on some clays from Texas. In Bulletin 470.

Eckel, C. E. Stoneware and brick clays of western Tennessee and northwestern Mississippi. In Bulletin 213, pp. 382–391. 1903. 25c.

——— Clays of Garland County, Ark. In Bulletin 285, pp. 407–411. 1906. (Out of print.)

Fenneman, N. M. Clay resources of the St. Louis district, Missouri. In Bulletin 315, pp. 315–321. 1907. 50c.

Fenneman, N. M. Geology and mineral resources of the St. Louis quadrangle. In Bulletin 438, pp. 49–54. 1911.

Fisher, C. A. The bentonite deposits of Wyoming. In Bulletin 260, pp. 559–563. 1905. 40c.

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Gilpin, J. E., and Bransky, O. E. The diffusion of crude petroleum through fuller's earth, with notes on its geologic significance. In Bulletin 475, 50 pp. 1911.

Katz, F. J. Clay in the Portland region, Maine. In Bulletin 530.

Landes, Henry. The clay deposits of Washington. In Bulletin 260, pp. 550–558. 1905. 40c.

Lines, E. F. Clays and shales of the Clarion quadrangle, Clarion County, Pa. In Bulletin 315, pp. 335–343. 1907. 50c.

Matson, G. C. Notes on the clays of Florida. In Bulletin 380, pp. 346–356. 1909.

——— Notes on the clays of Delaware. In Bulletin 530. 1912.

Middleton, Jefferson. Clay-working industries. In Mineral Resources U. S. for 1910, pt. 2, pp. 537–600. 1911.[1]

Miser, H. D. Developed fuller's earth deposits of Arkansas. In Bulletin 530. 1912.

Phalen, W. C. Clay resources of northeastern Kentucky. In Bulletin 285, pp. 412–416. 1906. (Out of print.)

——— Economic geology of the Kenova quadrangle, Kentucky, Ohio, and West Virginia. In Bulletin 349, pp. 112–122. 1908.

Phalen, W. C., and Martin, Lawrence. Mineral resources of Johnstown, Pa., and vicinity. Bulletin 447. 140 pp. 1911.

——— ——— Clays and shales of southwestern Cambria County, Pa. In Bulletin 315, pp. 344–354. 1907. 50c.

Porter, J. T. Properties and tests of fuller's earth. In Bulletin 315, pp. 268–290. 1907. 50c.

Richardson, G. B. Clay near Calhan, El Paso County, Colo. In Bulletin 470 1911.

Ries, H. Technology of the clay industry. In Sixteenth Ann. Rept., pt. 4, pp 523–575. 1895. $1.20.

——— The pottery industry of the United States. In Seventeenth Ann. Rept. pt. 3 (continued), pp. 842–880. 1896. $1.00.

——— The clays of the United States east of the Mississippi River. Professiona Paper 11. 298 pp. 1903. 40c.

Schrader, F. C., and Haworth, E. Clay industries of the Independence quadrangle, Kansas. In Bulletin 260, pp. 546–549. 1905. 40c.

Shaler, M. K., and Gardner, J. H. Clay deposits of the western part of th Durango-Gallup coal field of Colorado and New Mexico. In Bulletin 315, pp. 296–302 1907. 50c.

Shaler, N. S., Woodworth, J. B., and Marbut, C. F. The glacial brick clays c Rhode Island and southeastern Massachusetts. In Seventeenth Ann. Rept., pt. 1 pp. 957–1004. 1896. $2.00.

Shaw, E. W. Clay resources of the Murphysboro quadrangle, Illinois. In Bu letin 470. 1911.

Siebenthal, C. E. Bentonite of the Laramie Basin, Wyoming. In Bulletin 28 pp. 445–447. 1906. (Out of print.)

Stose, G. W. White Clays of South Mountain, Pennsylvania. In Bulletin 31 pp. 322–334. 1907. 50c.

Van Horn, F. B. Fuller's earth. In Mineral Resources U. S. for 1907, pt. pp. 731–734. 1908. $1.00.

——— Fuller's earth. In Mineral Resources U. S. for 1909, pt. 2, pp. 735–738. 191

Vaughan, T. W. Fuller's earth of southwestern Georgia and Florida. In Miner Resources U. S. for 1901, pp. 922–934. 1902. 50c.

——— Fuller's earth deposits of Florida and Georgia. In Bulletin 213, pp. 392–39 1903. 25c.

Veatch, O. Kaolins and fire clays of central Georgia. In Bulletin 315, pp. 30 314. 1907. 50c.

Woolsey, L. H. Clays of the Ohio Valley in Pennsylvania. In Bulletin 22 pp. 463–480. 1904. 35c.

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[1] Previous volumes of the Mineral Resources of United States contain chapters devoted to clay and t clay-working industries of the United States.

GLASS SAND, OTHER SAND, AND GRAVEL.

By Ernest F. Burchard.

INTRODUCTION.

The noteworthy features of the sand and gravel industry in 1911 as compared with the business of 1910 were the slight decrease in the production of building sand and gravel, the increase in the production of glass sand, and the fact that, notwithstanding the slight net decrease in total tonnage of sand and gravel produced, there was a slight increase in total value as compared with that of 1910.

The production of glass sand was reported from several new States, including Florida, Iowa, Kansas, Mississippi, Tennessee, and Texas. The deposit reported near Fall River, Kans., can hardly be considered to have made commercial shipments in 1911, although it gives promise of success. This is the deposit of undeveloped sandstone to which attention was called in Survey Bulletin 315,[1] issued in 1907. With regard to the deposits in the other newly reporting States, except Florida, the Survey has no information.

A special feature of this chapter is a summary of the papers on requirements of sand and limestone for glass making, and descriptions of deposits of glass sand published by the Survey in 1906 and 1907. This material has been reviewed here because of the continued inquiries that reach the Survey for information on this subject.

PRODUCTION.

The total production of sand and gravel in the United States in 1911, as reported to the United States Geological Survey, was 66,846,959 short tons, valued at $21,158,583, as compared with 69,410,436 short tons, valued at $21,037,630, in 1910, a net decrease in quantity of 2,563,477 short tons, but an increase in value of $120,953 as compared with the production of 1910. Of the 1911 total, the production of all kinds of sand was 40,253,977 short tons, valued at $14,438,500, and that of gravel was 26,592,982 short tons, valued at $6,720,083.

The production of glass sand in 1911 was 1,538,666 short tons, valued at $1,543,733, as compared with 1,461,089 short tons, valued at $1,516,711, in 1910. These figures represent an increase in quantity of 77,577 tons and in value of $27,022. The average value of glass sand per ton was approximately $1 in 1911 as compared with $1.04 in 1910.

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[1] Burchard, E. F., Notes on various glass sands, mainly undeveloped: Bull. U. S. Geol. Survey No. 315, 1907, pp. 377-382.

Sand used for building in 1911 amounted to 24,614,342 short tons, valued at $7,719,286, a decrease in quantity of 1,128,730 short tons and in value of $113,352 as compared with the production in 1910, which was 25,743,072 short tons, valued at $7,832,638. In the year 1911 there was slightly less activity in the building trades, including concrete construction work, consequently there was slight decrease in the consumption of sand and gravel for building. The production of molding sand in 1911 amounted to 3,376,717 short tons, valued at $2,132,469, as compared with 3,636,167 short tons, valued at $2,431,254 in 1910, a decrease in quantity of 259,450 tons and in value of $298,785.

The production of all other sands in 1911, including sand for grinding and polishing, fire sand, engine sand, furnace sand, paving sand, and sand for miscellaneous purposes not specified, including filtration sand, amounted to 10,724,252 short tons, valued at $3,043,012, as compared with 5,985,486 short tons, valued at $2,004,917, in 1910, an increase in quantity of 4,738,766 short tons and in value of $1,038,095.

The average value of molding sand per short ton in 1911 was about 63 cents, as compared with about 70 cents in 1910. The average value of building sand was about 35 cents per short ton, as compared with 30 cents in 1910. The other grades of sand bring various prices, the average in 1911 having been 28 cents per ton, although the value of fire sand was as high as 74 cents per ton. The average value for gravel in 1911 was about 25 cents per ton, as compared with a little less than 23 cents in 1910.

The gravel figures for 1911 do not include, as they did in 1910, a considerable quantity of chats or tailings from the Missouri zinc mines and of chert used for road building in Alabama and Tennessee. The production of chats in Missouri in 1911, as reported by the Missouri Bureau of Geology and Mines, was 1,503,603 tons.

The unit of measurement given in the following tables of production is the short ton. Much of the sand is reported as sold by the cubic yard, a cubic yard varying in weight from 2,300 to 3,000 pounds according to the condition of the sand, according to the material of which the gravel is composed, and according to the custom of the locality. All of the glass sand is sold by the short ton, and also a considerable quantity of the molding, building, and other sand; hence, the quantities reported were all reduced to this unit.

The following table gives the total production of sand and gravel in the United States in each of the last 10 years:

Quantity and value of sand and gravel produced in the United States, 1902–1911, in short tons.

Years.	Sand and gravel.	
	Quantity.	Value.
1902	1,847,901	[a] $1,423,614
1903	2,110,660	[a] 1,831,210
1904	10,679,728	[a] 5,748,099
1905	23,204,967	11,223,645
1906	32,932,002	12,698,208
1907	41,851,918	14,492,069
1908	37,216,044	13,270,032
1909	59,565,551	18,336,990
1910	69,410,436	21,037,630
1911	66,846,959	21,158,583

[a] Includes a very small quantity of gravel.

The following table gives the total production of glass sand in the United States in each of the last 10 years:

Quantity and value of glass sand produced in the United States, 1902–1911, in short tons.

Years.	Glass sand.	
	Quantity.	Value.
1902	943,135	$807,797
1903	823,044	855,828
1904	858,719	796,492
1905	1,060,334	1,107,730
1906	1,089,430	1,208,788
1907	1,187,296	1,250,067
1908	1,093,553	1,134,599
1909	1,104,000	1,163,375
1910	1,461,089	1,516,711
1911	1,538,666	1,543,733

The tables following give the production of the various grades of sand and the production of gravel by States in 1910 and 1911.

Production of glass sand, other sand, and gravel in the United States in 1910 and 1911, by States and uses, in short tons.

1910.

State.	Glass sand.		Molding sand.		Building sand.		Fire sand.		Engine sand.		Furnace sand.		Other sands.		Gravel.		Total.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Alabama			56,085	$22,069	228,797	$73,567			6,350	$1,930	286	$148	16,197	$2,547	311,538	$87,330	619,253	$187,591
Arizona																		(a)
Arkansas			600	515	212,318	68,791			18,370	5,140			7,511	5,978	822,238	150,256	1,061,037	230,680
California	(b)	(b)	c 10,133	c 9,342	191,247	74,225	10,695	$8,033	25,679	6,949			22,286	14,829	1,805,257	327,572	2,065,297	440,950
Colorado			3,857	2,627	41,168	13,050			7,065	2,200			13	15	1,145,648	136,147	1,197,751	154,039
Connecticut			295	779	15,969	11,924							412	72			16,676	12,775
Delaware			1,000	600	72,707	29,721			16,141	5,009	74,208	31,539					164,056	66,869
Florida			795	785	34,063	21,127											34,858	21,912
Georgia	(d)	(d)	e 42,355	e 19,341	237,752	75,098			6,800	1,700			40,397	11,029	25,075	15,975	352,379	123,143
Hawaii																		(a)
Idaho					15.800	11,700							675	750	16,200	12,000	32,675	24,450
Illinois	268,654	$216,531	407,232	215,742	1,756,652	473,209	17,840	12,886	43,147	6,840	79,793	48,046	1,211,564	150,756	4,801,626	626,785	8,586,508	1,730,795
Indiana	(d)	(d)	e 165,357	e 85,204	1,828,025	410,046			28,902	9,213	67,065	13,400	221,419	26,825	4,107,702	500,474	6,418,468	1,045,162
Iowa			13,320	9,775	781,667	283,086			25,000	7,033	9,000	4,500	25,235	5,563	944,540	154,470	1,798,762	464,427
Kansas					609,540	142,514			24,524	3,773			37,244	4,217	105,330	15,155	776,638	165,659
Kentucky	(d)	(d)	e 57,318	e 43,788	383,179	186,054	2,780	1,952	8,104	3,360	12,016	9,335	28,062	7,834	245,891	134,123	737,350	386,446
Louisiana					208,958	66,258			4,653	778			35,535	6,827	586,149	298,473	835,295	372,336
Maine					41,569	40,313											41,569	40,313
Maryland	b 25,392	b 22,996	(c)	(c)	476,817	163,213			21,872	12,437			13,477	9,882	416,835	187,829	954,393	396,357
Massachusetts	(d)	(d)	e 13,166	e 23,630	141,686	91,287	4,144	1,405					51,787	30,724	111,077	65,670	321,860	212,716
Michigan	(d)	(d)	e 110,024	e 49,679	1,151,588	334,336	5,000	3,000	22,270	2,172	3,185	4,924	372,880	57,385	1,197,791	364,841	2,862,738	816,337
Minnesota			23,099	26,422	176,858	62,470	100	100	9,838	1,511			23,444	9,849	1,704,773	246,786	1,938,112	347,138
Mississippi			256	166	70,932	30,734			9,407	2,554			1,485	1,430	281,041	124,598	363,121	159,482
Missouri	186,342	130,686	79,977	42,787	2,525,600	571,501	35,680	16,420	65,148	12,544			145,701	79,628	3,070,012	485,953	6,108,460	1,339,519
Montana																		(a)
Nebraska					801,762	129,641			9,691	1,321			170,749	18,644	94,400	18,649	1,076,602	168,255
New Jersey	87,680	61,078	679,191	436,460	1,431,332	340,288	28,931	32,562	20,786	9,666	14,757	9,246	171,886	111,383	528,252	138,592	2,962,815	1,139,275
New Mexico					223	207							2,700	680	1,387	1,156	4,310	2,043
New York	(d)	(d)	e 536,232	e 453,362	4,605,620	1,041,587	23,485	12,585	34,020	13,044	6,315	3,140	318,196	109,690	1,605,228	671,715	7,129,096	2,305,123
North Carolina			439	396	28,031	4,989							28,875	2,994	5,590	5,027	62,935	13,406
North Dakota					5,752	4,322							420	150	9,714	6,750	15,886	11,222
Ohio	139,122	104,295	724,313	533,343	2,062,103	713,220	11,474	8,576	63,023	19,366	94,965	85,051	73,681	44,357	1,937,833	557,016	5,106,514	2,065,224
Oklahoma			90	24	276,759	87,130			3,360	830			62,256	19,204	307,771	79,789	650,236	186,977
Oregon					434,068	269,878			7,000	500					991,427	355,027	1,432,495	625,405

Pennsylvania	434,147	617,200	605,340	413,741	2,245,658	941,327	32,062	36,719	229,233	150,659	105,194	58,673	601,528	388,896	1,423,347	367,006	5,676,509	2,974,221
South Carolina	[b] 2,144	[b] 1,993	([c])	([c])	2,138	925	......	......	......	......	......	......	500,000	50,000	......	......	504,282	52,918
South Dakota	......	......	......	......	60,325	32,606	......	......	2,205	294	......	......	925	825	786,345	124,013	849,800	157,738
Tennessee	1,320	1,344	48,129	24,439	376,016	187,646	540	500	36,337	12,731	9,271	4,722	18,937	6,842	304,862	179,677	795,412	417,901
Texas	......	......	4,186	2,649	480,057	227,649	150	300	23,290	13,280	112	84	27,064	9,488	471,725	263,775	1,006,584	517,225
Utah	......	......	......	......	2,560	723	......	......	13,886	4,167	......	......	120	245	166,928	16,219	183,494	21,354
Vermont	......	......	2,268	1,736	2,950	2,170	......	......	......	......	......	......	60,000	15,000	1,200	141	66,418	19,047
Virginia	([d])	([d])	[e] 36,217	[e] 25,404	251,170	88,340	......	......	1,900	1,165	5,339	2,088	22,494	10,628	447,201	87,791	764,321	215,416
Washington	......	......	4,070	7,577	588,846	176,102	......	......	950	550	......	......	5,136	2,013	976,287	295,327	1,575,289	481,569
West Virginia	235,784	282,267	3,541	2,461	231,535	87,109	......	......	47,777	29,280	11,500	3,350	53,982	13,878	161,122	56,116	745,241	474,461
Wisconsin	([d])	([d])	[e] 87,786	[e] 54,732	638,861	256,284	42,200	1,323	41,683	7,149	560	800	39,909	12,524	640,759	92,751	1,451,758	425,563
Other States[f]	......	......	......	......	14,416	6,271	......	......	......	......	......	......	24,246	16,784	24,521	1,136	63,183	24,191
Total	[g] 1,380,585	[g] 1,438,390	[h] 3,716,671	[h] 2,509,575	25,743,072	7,832,638	175,081	136,361	878,411	349,145	493,566	279,046	[i] 4,438,428	[i] 1,240,365	52,584,622	7,252,110	69,410,436	21,037,630

[a] Included in "Other States."
[b] Includes molding sand.
[c] Included in glass sand.
[d] Included in molding sand.
[e] Includes glass sand.
[f] Includes Arizona, Hawaii, and Montana.
[g] The exact output of glass sand was 1,461,089 tons, valued at $1,516,711.
[h] The exact output of molding sand was 3,636,167 tons, valued at $2,431,254.
[i] Includes sand for grinding and polishing stone and glass, filtration sand, railroad filling and ballast, brick molding, for asphalt paving and blocks, etc.

Production of glass sand, other sand, and gravel in the United States in 1910 and 1911, by States and uses, in short tons—Continued.

1911.

State.	Glass sand.		Molding sand.		Building sand.		Grinding and polishing sand.		Fire sand.		Engine sand.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Alabama			52,766	$19,432	201,214	$70,284	(*a*)	(*a*)			(*a*)	(*a*)
Arizona					(*a*)	(*a*)			(*a*)	(*a*)		
Arkansas			197	170	129,271	42,813					32,865	$7,277
California	(*a*)	(*a*)	14,153	14,757	371,681	123,565	(*a*)	(*a*)	(*a*)	(*a*)	19,695	9,556
Colorado			7,195	2,492	45,379	23,404					46,171	2,780
Connecticut			1,335	2,465	18,825	7,990						
Delaware					66,904	33,672	(*a*)	(*a*)	(*a*)	(*a*)	(*a*)	(*a*)
Florida	(*a*)	(*a*)	69,745	7,978	41,482	22,704	(*a*)	(*a*)				
Georgia	(*a*)	(*a*)	14,684	6,879	283,456	105,231					16,540	3,828
Idaho					(*a*)	(*a*)						
Illinois	251,907	$171,978	237,359	120,690	1,875,814	691,846	59,880	$41,765	36,090	$15,141	46,897	6,158
Indiana	(*a*)	(*a*)	156,993	56,777	2,002,159	409,586	53,047	5,335	(*a*)	(*a*)	174,407	58,676
Iowa	(*a*)	(*a*)	5,271	4,582	718,078	226,675			(*a*)	(*a*)	19,713	5,527
Kansas	(*a*)	(*a*)	(*a*)	(*a*)	244,376	61,727					143,135	25,947
Kentucky	(*a*)	(*a*)	24,222	24,426	463,430	210,551	(*a*)	(*a*)	(*a*)	(*a*)	(*a*)	(*a*)
Louisiana					145,079	78,305					(*a*)	(*a*)
Maine					26,432	23,302						
Maryland	(*a*)	(*a*)	1,422	3,307	311,079	134,134	(*a*)	(*a*)			22,445	18,187
Massachusetts	(*a*)	(*a*)	9,629	7,899	217,837	135,930			(*a*)	(*a*)		
Michigan	(*a*)	(*a*)	68,878	17,901	833,729	247,997	(*a*)	(*a*)	(*a*)	(*a*)	(*a*)	(*a*)
Minnesota			27,007	23,731	367,648	78,255					7,734	1,451
Mississippi	(*a*)	(*a*)	8,264	3,416	151,650	62,230	(*a*)	(*a*)			(*a*)	(*a*)
Missouri	117,756	82,705	92,679	49,522	1,983,751	533,722	101,239	55,884	6,689	2,371	33,850	14,000
Montana					(*a*)	(*a*)						
Nebraska					629,173	107,955					(*a*)	(*a*)
Nevada					(*a*)	(*a*)					(*a*)	(*a*)
New Jersey	91,530	68,549	715,654	392,840	1,501,951	242,659	(*a*)	(*a*)	64,977	67,503	45,743	12,310
New Mexico					5,475	2,165	(*a*)	(*a*)			(*a*)	(*a*)
New York			505,256	421,503	4,750,927	1,105,618	5,770	2,693	21,105	9,855	18,953	8,264
North Carolina			784	685	5,957	2,678					(*a*)	(*a*)
North Dakota					8,136	5,680						
Ohio	119,991	125,576	533,163	394,145	2,235,333	786,360	9,633	12,220	15,211	12,612	47,621	16,523
Oklahoma			(*a*)	(*a*)	104,353	37,481					(*a*)	(*a*)
Oregon					397,614	222,116						
Pennsylvania	478,089	668,247	657,197	451,779	2,072,830	882,516	500,604	326,490	37,638	33,238	167,203	110,017
South Carolina	(*a*)	(*a*)	(*a*)	(*a*)	1,484	997	(*a*)	(*a*)			(*a*)	(*a*)
South Dakota			(*a*)	(*a*)	24,402	11,030	1,324	555			(*a*)	(*a*)

Tennessee	(a)	(a)	17,156	10,703	429,793	212,979	12,320	5,800			34,656	10,556
Texas	(a)	(a)	3,406	2,857	381,564	217,614	(a)	(a)	(a)	(a)	18,410	2,858
Utah			405	100	9,463	3,375	900	465	(a)	(a)	(a)	(a)
Vermont			(a)	(a)	(a)	(a)	(a)	(a)				
Virginia	(a)	(a)	41,533	18,303	216,756	98,675			(a)	(a)	7,845	3,220
Washington			(a)	(a)	293,029	84,438					(a)	(a)
West Virginia	268,368	313,758	2,267	1,620	205,194	93,037			(a)	(a)	29,949	20,606
Wisconsin	(a)	(a)	90,723	59,009	774,045	245,879	(a)	(a)	(a)	(a)	25,650	3,668
Wyoming					(a)	(a)					(a)	(a)
Concealed totals	211,025	112,920	17,374	12,501	67,589	32,111	193,911	70,554	31,813	17,304	170,513	69,899
Total	1,538,666	1,543,733	3,376,717	2,132,469	24,614,342	7,719,286	938,628	521,761	213,523	158,024	1,129,993	411,308

State.	Furnace sand.		Paving sand.		Other sands.		Total production of sand.		Gravel.		Grand total.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Alabama	36,540	$7,738	10,975	$3,635	14,988	$7,391	356,293	$119,758	321,601	$95,655	677,894	$215,413
Arizona							30,387	b 22,215			30,387	22,215
Arkansas			48,830	12,900	(a)	(a)	279,303	73,508	728,286	110,389	1,007,589	183,897
California			35,412	12,601	48,216	16,730	501,473	187,462	1,410,179	229,518	1,911,652	416,980
Colorado	(a)	(a)	31,249	2,032	9,132	2,781	148,360	37,196	99,306	28,170	247,666	65,366
Connecticut					(a)	(a)	20,270	10,559			20,270	10,559
Delaware	58,553	25,911					137,205	65,813			137,205	65,813
Florida					(a)	(a)	112,776	33,339			112,776	33,339
Georgia			5,083	1,156	108,245	22,159	434,608	145,193	84,277	30,541	518,885	175,734
Idaho											(c)	(c)
Illinois	26,017	10,502	318,671	125,624	1,862,000	164,292	4,714,635	1,347,996	3,774,048	642,926	8,488,683	1,990,922
Indiana	142,163	14,390	54,361	23,578	1,713,078	153,584	4,430,060	751,090	1,603,099	382,739	6,033,159	1,133,829
Iowa	(a)	(a)	47,819	13,579	80,191	12,143	883,117	268,626	465,887	125,023	1,349,004	393,649
Kansas			(a)	(a)	189,401	38,148	(a)	(a)	(a)	(a)	734,507	164,058
Kentucky	9,927	4,410	4,975	2,875	28,279	15,603	546,631	268,350	360,274	121,218	906,905	389,568
Louisiana			(a)	(a)	261,570	42,413	421,114	123,326	548,145	220,955	969,259	344,281
Maine					(a)	(a)	(a)	(a)	(a)	(a)	33,308	30,088
Maryland			4,188	1,333	(a)	(a)	364,132	176,416	118,020	70,070	482,152	246,486
Massachusetts	(a)	(a)	14,485	11,455	33,547	6,418	281,603	167,433	92,723	55,389	374,326	222,822
Michigan	(a)	(a)	152,144	29,650	55,149	10,751	1,250,093	362,751	935,072	203,218	2,185,165	565,969
Minnesota			39,350	6,730	97,087	20,281	538,826	130,448	983,469	269,532	1,522,295	399,980
Mississippi			(a)	(a)	58,463	31,383	275,933	141,910	355,151	144,296	631,084	286,206
Missouri	(a)	(a)	41,610	15,364	79,770	27,293	2,460,212	783,411	1,145,701	259,263	3,605,913	1,042,674
Montana							(a)	(a)	(a)	(a)	5,143	2,461
Nebraska			122,246	20,044	33,219	3,879	789,349	132,149	68,939	24,628	858,288	156,777
Nevada							(a)	(a)	(a)	(a)	223,510	33,591
New Jersey	6,895	6,991	157,861	40,912	49,699	27,668	2,635,710	860,732	717,055	198,194	3,352,765	1,058,926
New Mexico							7,770	3,555	259,845	15,219	267,615	18,774
New York	(a)	(a)	82,720	46,818	172,580	95,282	5,561,410	1,691,328	1,976,168	723,124	7,537,578	2,414,452

a Production of States having less than three producers is included under "Concealed totals."

b Includes building sand from Idaho.

c Included in Arizona.

Production of glass sand, other sand, and gravel in the United States in 1910 and 1911, by States and uses, in short tons—Continued.

1911.

State.	Furnace sand.		Paving sand.		Other sands.		Total production of sand.		Gravel.		Grand total.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
North Carolina			(*a*)	(*a*)	74,320	$40,475	(*a*)	(*a*)	(*a*)	(*a*)	251,977	$93,336
North Dakota					(*a*)	(*a*)	8,406	$5,710	14,754	$10,085	23,160	15,795
Ohio	66,760	$59,790	105,073	$38,901	147,347	59,929	3,280,132	1,506,056	2,001,505	598,720	5,281,637	2,104,776
Oklahoma			15,989	5,382	(*a*)	(*a*)	128,124	45,855	163,300	51,684	291,424	97,539
Oregon					498,921	136,191	896,535	358,307	541,969	301,110	1,438,504	659,417
Pennsylvania	53,015	28,884	259,121	88,992	85,968	84,861	4,311,665	2,675,024	1,377,394	350,243	5,689,059	3,025,267
South Carolina							(*a*)	(*a*)	(*a*)	(*a*)	227,612	30,303
South Dakota					6,589	2,660	33,268	14,395	59,489	26,891	92,757	41,286
Tennessee	8,661	2,325	16,688	8,876	8,925	2,725	529,649	255,014	587,660	263,528	1,117,309	518,542
Texas			46,130	28,000	20,530	5,772	470,873	257,897	577,479	285,969	1,048,352	543,866
Utah			13,480	8,060	5,263	1,375	40,736	16,185	104,121	9,704	144,857	25,889
Vermont							(*a*)	(*a*)	(*a*)	(*a*)	104,852	52,540
Virginia	10,730	6,270	11,956	4,275	23,500	3,775	315,558	137,748	238,438	66,422	553,996	204,170
Washington			(*a*)	(*a*)			396,454	136,074	748,915	202,326	1,145,369	338,400
West Virginia	(*a*)	(*a*)	35,485	9,743	95,003	38,295	641,281	478,569	108,110	53,819	749,391	532,388
Wisconsin	(*a*)	(*a*)	6,418	3,988	101,430	20,255	1,107,303	345,996	2,659,552	385,696	3,676,855	731,692
Wyoming							(*a*)	(*a*)	(*a*)	(*a*)	784,865	58,548
Concealed totals	39,356	22,498	238,716	66,466	76,509	16,089	1,046,806	420,141	1,363,051	163,819		
Total	458,617	189,709	1,944,572	651,609	6,038,919	1,110,601	40,253,977	14,438,500	26,592,982	6,720,083	66,846,959	21,158,583

[a] Production of States having less than three producers is included under "Concealed totals."

IMPORTS.

Sand valued at $147,268 was imported into the United States in 1911, as compared with imports valued at $133,757 in 1910 and at $106,234 in 1909.

THE REQUIREMENTS OF SAND AND LIMESTONE FOR MAKING GLASS.[1]

INTRODUCTORY STATEMENT.

The United States Geological Survey has received so many requests for information concerning glass sand that the stock for free distribution of the principal special bulletin on this subject, Bulletin 285, has been exhausted. It has therefore been decided to republish here the essential facts given in that publication and in Bulletin 315, although there has been no opportunity since 1906 for supplementary field work in the areas described nor for new field work in other areas. In Bulletins 285 and 315 many individual glass-sand quarries and plants were described, but since these descriptions are based on conditions prevailing in 1905 and 1906 it has seemed best to generalize the descriptions here without reference to individual plants.

During 1905 and 1906 several important glass-manufacturing districts were visited by Survey geologists, and careful investigation has been made of the sands and other raw materials used in the manufacture of glass. The results of this work are summarized in the following report.

The data were derived from a brief study of the glass sands of certain States in the Mississippi basin and West Virginia. Glass manufacture admits of such slight variations in the character of its raw materials that the materials described are regarded as representing very fairly the grade demanded for the industry at large. The points here considered are intended mainly to serve as a guide to persons who wish to know whether certain sandstones or limestones may be suitable for glass making.

DEFINITION AND COMPONENTS OF GLASS.

Glass is a fused mixture of the silicates of alkalies, alkaline earths, and of more common metals. Usually the alkaline bases are sodium and potassium, the alkaline earth is calcium, and the common metallic element is lead. All of these are used in the form of salts. In melting together the various ingredients employed in the batch or mixture it appears that silica under the influence of heat in the presence of a flux forms silicates with sodium or potassium, and calcium, lead, etc., and the alkaline silicate then dissolves the remaining silicates. It is this solution that solidifies into glass on cooling. Glass may be divided into four general classes—plate, window, green bottle, and flint. Owing to manufacturing conditions, few makers follow the same formula, but the following table shows the general proportion by weight which sand bears to the other ingredients commonly used in certain types of American-made glass:[2]

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[1] Burchard, E. F., The requirements of sand and limestone for glass making: Bull. U. S. Geol. Survey No. 285, 1906, pp. 452–458.

[2] Data, except for lime flint, are according to Robert Linton's article on Glass, in Mineral Industry for 1899, vol. 8, 1900, pp. 244–245.

General proportions, by weight, of various components of glass.

Component.	Plate glass.	Window glass.	Green bottle.	Lead flint.	Lime flint.
Sand (SiO_2)	100	100	100	100	100
Salt cake (Na_2SO_4)		42	38		
Soda ash (Na_2CO_3)	36				36
Limestone ($CaCO_3$)	24	40	34		
Carbon (C)	.75	6	5		
Arsenic (As_2O_3)	1	2		.15	.02
Slaked lime ($Ca(OH)_2$)					12
Potash (K_2CO_3)				34	
Red lead ($2PbO+PbO_2$)				48	
Niter ($NaNO_3$)				6	1
Manganese (MnO_2)				.06	6.66
Antimony (Sb)				.02	.23

REQUIREMENTS OF GLASS SAND.

Sand is therefore the major constituent of glass, constituting from
52 to 65 per cent of the mass of the original mixture, or from 60 to 7
per cent of the finished product after melting has driven off carbor
dioxide, sulphur dioxide, and other volatile materials. To the sanc
is due the absence of color (according to its purity), the transparency
brilliancy, and hardness of glass. In other words, the quality of th
glass depends largely on the quality of the sand. For the finest flin
ware, such as that used for optical and cut glass, "water whiteness,'
absolute transparency, great brilliance, and uniform density ar
required, and only the purest sand can be employed, since sligh
impurities, especially small quantities of iron, tend to destroy thes
effects. For plate and window glass, which are commonly pale green
absolute purity is not so essential, but generally the sand should no
carry more than 0.2 per cent of ferric oxide. Green and amber glas
for bottles, jars, and rough structural work can be made from san
relatively high in impurities. An excess of the chief impurity, iron
is usually avoided in the quarries by a careful selection of the whites
sand, although the whitest sand is not invariably the purest. Re
peated washing tends to remove the iron. Magnetic separators als
have been resorted to, especially when the iron is present in the forr
of magnetite. Clay materials are objectionable because they clou
the glass. Washing helps to remove them, since they occur usuall
in a very finely divided state. Magnesia, which is more apt to b
introduced into glass materials through limestone that through sanc
is troublesome because it renders the batch less fusible. If the san
is derived from indurated sandstone the latter should be friable c
easily crushed. In examining sand in order to ascertain its value fc
glass making, inspection with a magnifying glass is the best prelim
nary test. The following points should be observed: The sand shoul
be nearly white in color; it should be of medium fineness (passing
20 to 50 mesh horizontal sieve); the grains should be uniform in siz
even, and angular, or, less preferably, they may be rounded.
simple chemical test may be employed by heating the sand in a dilu
acid. Effervescence indicates the presence of lime; loss of col
shows the presence of clay impurities. Iron in the most minu
quantity may be detected by dissolving sand in hydrofluoric ac
and adding potassium ferrocyanide, which produces a blue precipita
if iron is present. Complete quantitative analyses as well as a furna
test should be made as a final determination of the character of

prospective glass sand. The impression has long prevailed, especially among writers on the subject of glass making, that round-grained sands are at a decided disadvantage in comparison with the sharp, angular variety. Practice seems to disagree with this idea, at least in the case of the Mississippi Valley plants, where smooth, rounded sand is successfully used for all ordinary varieties of glass and for some fine flint ware. As a rule, no very close check is kept on materials by manufacturers of the ordinary commercial grades of glass. Results are watched with care, however, and experience with certain materials usually determines their use or rejection. Sand uniformly finer than one-sixtieth inch is said to "burn out" in the batch and not to produce as much glass per unit of weight as does coarser sand. In a mixture of coarse and fine sand the finer sand is liable to settle to the bottom of the batch, thus preventing an even mixture of the materials and producing in consequence a glass uneven in texture.

REQUIREMENTS OF LIMESTONE.

In its connection with sand as a glass material limestone is of interest to quarrymen. As shown in the table on page 594, limestone enters the batch of several kinds of glass to the extent of about 18 per cent of its mass. The rock is crushed, ground finely, and screened. Purity is as essential in limestone as in sand, and it is probable that much of the impurity which finds its way into the batch comes unsuspectedly from the limestone. Limestone should therefore be analyzed frequently, as it may carry clay and iron pyrites as well as carbonates of iron and magnesia, all of which are objectionable for reasons previously stated. Moreover, beds in the same quarry often vary in composition within short distances. Limestone of good quality, belonging mainly to the Carboniferous system, is widely distributed in Illinois, Missouri, Kansas, and other central glass-manufacturing States, and, compared with sand, it brings a high price. Analyses of certain limestones used in this industry are given below, and many suitable limestones are described in Survey Bulletin 522, on the Portland cement materials and industry of the United States.

Analyses of limestone used in glass making.

Operator and location of quarry.	Lime carbonate ($CaCO_3$).	Magnesium carbonate ($MgCO_3$).	Iron oxide (Fe_2O_3).	Alumina (Al_2O_3).	Silicates and silica SiO_2).	Authority.
Meramec Quarry Co., Wickes, Mo.	90.23	0.0	0.59	....	8.87	F. P. Mason.
Do	97.96	.18	....	....	1.86	Wm. Chauvenet.
Armstrong Quarry, Alton, Ill.	97.72	0.0	.20 (Fe_2CO_3.)	1.10	1.01	S. E. Swartz.
John Loughlin, Mitchell, Ind.	98.54	.58	.43		.63	American Window Glass Co.
Campbell Stone Co., Afton, Mich.	98.80	....	....	....	....	C. S. Lindford.
Carthage Superior Marble & Limestone Co., Carthage, Mo.	98.90	.07	.30		[a] .72	
Casparis Stone Co., Columbus, Ohio.	94.80	1.21	.80		3.20	J. C. Dickson.
American Lime & Stone Co., Bellefonte, Pa.	98.50	.37	[b] .15	.19	.79	Otto Wuth.
Thomasville Stone & Lime Co., Thomasville, Pa.	99.08	.34	.08	....	[a] .47	Franklin Menges.

[a] Insoluble in acids.

[b] Iron carbonate, $FeCO_3$.

METHODS OF PREPARATION OF SAND AND DESCRIPTIONS OF DEPOSITS.[1]

GENERAL STATEMENT.

Illinois and Missouri together now furnish about 370,000 short tons annually, nearly 25 per cent of the total output of glass sand in the United States. Pennsylvania produces about 30 per cent, and ranks first in quantity of this product, with Illinois second, Ohio third, and Missouri fourth. According to the latest complete statistics (for 1911) the average value of glass sand per ton in Pennsylvania is about $1.40, in Illinois 94 cents, and in Missouri 70 cents. This notable difference in prices between Pennsylvania and western sand is accounted for in part by the fact that Pennsylvania sand is somewhat more expensive to produce, being made from harder rock. A sharper, even-grained, and consequently a slightly more desirable glass sand is the result. Pennsylvania, West Virginia, and Maryland sands, all sold at a high price, are consumed for the most part within those States, and the importation of western sand would be expensive. Therefore prices are largely controlled by the cost of western sands plus freight charges. In the Mississippi Valley glass sand is produced principally from the Fox River district in north-central Illinois, near Ottawa, and from Missouri just west of St. Louis. These sands, besides supplying a large local demand, are shipped to all points within a radius of 500 miles, and frequently to a greater distance. Silica for other purposes, such as steel castings, linings of acid converters, fire brick, etc., is regularly shipped to Pacific coast points—Portland, Tacoma, and San Francisco.

The preparation of glass sand has become a highly specialized business, and in the middle Mississippi Valley 25 or more thoroughly equipped plants are at present employed. The large investments in sand properties and mills have developed very active competition between these establishments, and this competition has resulted in great care in the preparation of glass sand and in a high-grade product. Besides glass sand almost an equal quantity of other sand is produced at these plants for various purposes, such as molding, lining furnaces, sawing stone, grinding plate glass, and glazing pottery. Most of this sand requires less care in selection and preparation, yet it brings almost as high a price as glass sand and therefore yields more profit.

The method of treatment of glass sand depends on the character of the deposit and on its position. The materials used for glass sand in central United States are mainly bedded sandstones, and a complete process of preparation includes quarrying, breaking, crushing and grinding into component grains, screening, washing, draining drying, and final screening to various sizes. Some beds of sandstone are so friable and pure that only blasting down and slight crushing are necessary before the sand is dried and screened. Many plants however, wash their sand in course of preparation, particularly those in Illinois, where hydraulicking is employed to obtain sand from the quarries. Washing doubtless removes, even from high-grade sand considerable silica in such a fine state as to be detrimental, as well a an appreciable quantity of undesirable impurity, mainly clay, as is indicated by the following analysis of slime from washings of sand at Ottawa:

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[1] Burchard, E. F., Glass sand of the middle Mississippi basin: Bull. U. S. Geol. Survey No. 285, 1906 pp. 459–472; Glass sand industry of Indiana, Kentucky, and Ohio: Bull. U. S. Geol. Survey No. 315, 1907 pp. 361–376; Notes on various glass sands, mainly undeveloped: Idem, pp. 377–382. See also Stose, G. W The glass sand industry in eastern West Virginia: Bull. 285, pp. 473–475.

Analysis of slime from washings of Ottawa, Ill., sand.

Silica (SiO_2)	87.21
Alumina (Al_2O_3)	7.50
Ferric oxide (Fe_2O_3)	.52
Calcium oxide (CaO)	None.
Magnesium oxide (MgO)	None.
Sodium oxide (Na_2O) Potassium oxide (K_2O)	.20
Remainder mainly H_2O.	95.43

It is mistaken economy to neglect this important phase of treatment on account of the expense of installing washers, for the price of sand, and often its use or rejection, is affected by the small percentage of impurity that may be washed away. Two methods of washing are followed. One method involves several sets of bins, into which sand and water are elevated or pumped so that the sand settles quickly while the finer impurities are washed away; the other employs a crude, open-top pug mill, in which rotating "augers" or screws move the sand up inclined troughs, rolling it over and over so that by attrition it is freed from a large portion of its impurities and stain, and the impurities are then readily removed by a stream of water playing down the troughs.

Two methods of drying sand are in common use—the rapid method, effected by means of rotary cylindrical driers, which operate on a principle similar to that applied in cement mills, and the slower method of allowing the sand to settle through coils of steam pipes. In the rotary driers the cylinder is slightly inclined to the horizontal; damp sand is fed in at the higher end and, aided by gravity, moves gradually toward the lower end of the cylinder. Heated and incandescent gases are forced into the cylinder, the interior of which may be fitted with an angle iron that lifts and drops the sand alternately, thus exposing it more completely to the action of heat. There is some objection to this method on the ground of overheating the sand and the consequent danger of its setting fire to the bins. If the heat is properly regulated, or if bins are of fireproof material, the danger is minimized, and since drying is completed in from 5 to 10 minutes great economy of time is effected—an essential feature where a large output is desired. Stationary roasters are used at a few small plants. Fuller discussion of methods of obtaining and preparing sand will be found in the descriptions of quarries below.

In the accompanying tables are given the chemical composition and physical properties of twelve sands from Arkansas, Missouri, Kansas, and Wisconsin. These sands have attracted attention either by their purity and general fitness or by their proximity to manufacturing centers. Direct comparison with sands of proved value can be made by reference to other tables in this paper.

ILLINOIS.

The glass-sand industry in Illinois is mainly centralized in Lasalle County, along Illinois and Fox rivers near their junction. Topographic maps of the Lasalle and Ottawa quadrangles, comprising this area, are issued by the Survey. The St. Peter sandstone, which is the rock utilized, has been exposed in this area as the result of erosion across a low anticlinal fold, the axis of which passes northwest and southeast about 2 miles below Utica. The lowest rock exposed along the axis of this fold is a magnesian limestone containing natural cement-rock beds. It lies just below the St. Peter sandstone and is exposed along Illinois River valley for about 3 miles below Utica. The dips on the west limb of the anticline are very marked near the axis, but to the east they are more gentle, and in both directions the dip flattens out so as to become imperceptible. Illinois River flows in a broad, flat, rock-bottomed valley with precipitous sides, and below the rock floor of the valley the stream has cut its present channel from 20 to 30 feet in depth. As a consequence of the steep westward dip, which occurs about 1½ miles east of Lasalle, the extent of the St. Peter sandstone on the west limb of the anticline is limited to a few hundred yards. Northward beyond the river valley the sandstone forms the country rock over several townships. Eastward from Utica to Ottawa the broad Illinois Valley is cut in the flat-lying sandstone, as is the narrower valley of Fox River, to a point above Wedron. Limestones of Carboniferous and occasionally of Trenton (Ordovician) age overlie the sandstone along the valley bluffs. Transportation facilities are extremely favorable, since two railroads traverse the valley at Ottawa, and this advantage, together with the inexhaustible quantity of very pure sand easily obtained, has brought the production of silica into prominence among the activities of the Illinois Valley.

Ottawa.—In the vicinity of Ottawa glass sand is derived from open pits sunk below the level of the valley bottom. The St. Peter sandstone lies horizontal and is everywhere near the surface throughout this portion of the valley. At these quarries a few inches to 3 feet of soil and glacial débris have been scraped away, laying bare the old waterworn and potholed surface of the sandstone. At the sides of the valley the formation rises 30 to 50 feet above the valley floor, and drilling is reported to have shown the deposit to extend 280 feet below it, so that its total thickness is probably in excess of 300 feet. Only 60 to 75 feet of sand are worked on account of heavy ground water. The sand is mostly massive, and is frequently cross-bedded. It is generally pure white and free from clay where freshly exposed in this district, but the water that flows from the lower portion of the pits leaves a strong iron stain. Being very friable, the sandstone breaks down almost completely in blasting, and the loose sand is washed down by streams from small nozzles, through screens, into pumps. The pumps force the water and sand through 6-inch pipes along the quarry bottom either to elevators, which carry the wet sand up into the mills, or else the sand is pumped all the way up to the mills above the quarries. Here the sand is washed two or three times, dried, and screened and is ready for shipment. The prepared sand is perfectly white and consists of well-rounded waterworn grains averaging coarser than sands from the othe States mentioned in this article.

The sand in the vicinity of Ottawa is used for all grades of glassware. The best grades are used for cut glass and pressed glass, and much is sold for flint glass and bottles. Some sand is sold for furnace linings and for stone sawing, and large quantities are sold as the standard sand for testing cement.

Utica.—Below Ottawa, along the Chicago, Rock Island & Pacific Railway, are a number of small sand banks producing mainly crude sand from the upper part of the St. Peter sandstone, but as Utica is approached the sandstone rises higher in the bluff, bringing the fine quality of sand into convenient position for quarrying. Several quarries situated from ½ mile to 1½ miles east of town, produce mainly a good grade of sand, which is loaded directly on cars at the quarry without crushing or screening; they also produce glass sand, employing hydraulic jets and pumps to move the material down from the bluff to the mills.

MISSOURI.

The belt of St. Peter ("Pacific") sandstone between Klondike, on Missouri River, about 40 miles above its mouth, and Crystal City, on the Mississippi, 40 miles below St. Louis, contains the principal glass-sand plants of the State. This district is partly covered by the Survey topographic maps of the St. Louis, O'Fallon, and De Soto quadrangles. The rocks dip slightly to the northeast, but so slightly that locally they may be regarded as being horizontal. The outcrop of the sandstone in this region is from one-half mile to 5 miles wide. On the southwest the sandstone is bounded by older Ordovician dolomite and chert; to the east it passes beneath later Ordovician dolomite, which is in turn overlain by Devonian and Mississippian limestone and shale. Mississippian and later strata constitute the country rock at St. Louis and beyond the river in Illinois, where they pass beneath the main areas of Pennsylvanian coal-bearing rocks.

Klondike.—Glass sand is produced at Klondike, on the north side of Missouri River about 40 miles above its mouth. The base of the St. Peter sandstone here is 80 or more feet above Missouri River, which flows close to the base of the bluff, just beyond the tracks of the Missouri, Kansas & Texas Railway. The sandstone is about 80 feet thick. It lies on an irregular surface of cherty magnesian limestone or dolomite, the unconformity between the two formations being well displayed in the east pit of the quarry, where small domes of cherty rock extend up into the sandstone and coarse sandstone fills the hollows in the limestone floor. Overlying the St. Peter is a bed of soft greenish sand and clay shale, succeeded by alternating thin beds of sandy limestone, oolitic siliceous bands, clay shale, and earthy limestone, with more massive magnesian limestone beds above, the whole cover aggregating about 30 feet at the summit. This overlying formation has been termed the "First Magnesian" limestone. At present the removal of this overburden is a dead loss, since the rock is not considered of value for any purpose.

In texture the sandstone displays the well-known St. Peter characteristics of well-rounded, medium-sized grains (see table, p. 44) and is so friable as to be easily crushed. The upper 25 to 30 feet are slightly colored pink or brown in places. Lower down it becomes pure white or faint yellow. No marked cross-bedding is noticeable here, but in places there are distinct but not persistent horizontal bedding planes. Impurities are rare. Occasionally a small speck or "button" of iron oxide is encountered, cementing the adjacent sand grains into a very hard lump, but these harder masses are removed in screening. The glass-sand quarries at Klondike extend about one-fourth mile along the face of the bluff. When visited in 1905 the sand was "shot" down and gathered by means of tram cars drawn by mules to central points in the several pits, where the cars were picked up by cable and drawn to the mill. The sand was dumped directly into crushers, from which it passed to the driers. It was elevated to the screens and then fell into bins, from which it was drawn off into railroad cars for shipment. There were twin mills built on the terrace capping the steep slope between the railroad track below and the base of the sandstone. Each mill was equipped with Gates gyratory crushers, rotary-drum driers, elevators, screens, bins, and chutes. The power house was on the river bank across the track from the mill. The position of the sand bed, high in the bluff, is of advantage in many ways. The quarries are easily drained and can be worked to the full thickness of the sandstone. Although difficulties were encountered in the erection of the mill on the steep face of the bluff, its position in relation to the sandstone was of advantage, for gravity is made to play a large part in the process of handling the sand from the quarry to the railroad cars. The topography of the tract being worked here favors long continuance of the industry. When stripping of the beds overlying the sandstone has been carried as far as practicable on the river front, quarrying may be begun on the north side of the narrow divide which lies between the river and the small ravine parallel to it, about one-fourth mile to the north. After considerable quarrying has been done on the north side the thickest limestone cover in the middle of the ridge may be economically stripped back into the north quarry, making available the whole block of sandstone constituting the ridge back of Klondike and extending nearly one-half mile east. As the dip of the formation is to the northeast, the overburden presents an ever-increasing thickness in this direction, so that the eastward limit of profitable quarrying will be determined largely by this factor. As the sandstone in the upper 25 to 30 feet is slightly colored, it is usually kept separate from the whiter material below, which is prepared for glass making. The poorer grade of sand, after being crushed, dried, and screened, is sold mainly to steel foundries. An analysis of sand prepared for glass making from this quarry is given on page 624.

Grays Summit.—Nearly a mile northeast of the Missouri Pacific depot at Grays Summit, and 6 miles south-southeast of Klondike glass-sand quarries have been operated intermittently for severa years. Lying nearly in strike with the beds at Klondike, the St Peter sandstone is here at a high elevation on the divide between the Missouri River drainage basin and that of the Meramec. The quarries are located on the southeastern slope of the divide and are connected with the Missouri Pacific Railway by a spur. Seventy-five to 80 feet of the formation had been exposed in 1905 by stripping and quarrying The base was not exposed, but the top is overlain by the "First Magnesian" limestone. A total thickness of 167 feet was reported at this place, based on the measured thickness of the exposed portion plus a thickness noted in a drill hole. The actual thickness could not be measured at the time of visit, but it seems rather doubtful that the thickness of the formation should be doubled within 6 miles. How ever, it is obviously thicker at Grays Summit than at Klondike. The character of the sand shows no marked variation from that of the district in general. The color is uniformly white, except for faintly tinted bands, the rock from which is easily segregated and run separately through the mill, so that a product of uniform grade is insured. Some small lumps of iron oxide cementing the sand into concretions occur, but these are easily removed by screening. The sand is crushed, screened, and dried at this plant. The principle of operation is essentially the same as that employed at Klondike, but there were differences worth noting. After being "shot" down, the sand was brought by tram cars to a 30-inch belt conveyer, which carries it into the mill on a level with the base of the quarry and empties it into a hammer crusher. A wet screen intervened between the crusher and the revolving driers, which were heated directly by blast from coke as a fuel. After drying the sand was once more screened before being stored.

Pacific.—For more than 30 years the shipping of sand has been one of the leading industries of Pacific, a town on both the Frisco and the Missouri Pacific railroads, about 35 miles west of St. Louis, and to the conspicuous occurrence of the St. Peter sandstone at this place is due its local name, "Pacific" sandstone. From beyond the western boundary of the town eastward for about one-half mile the sandstone is well situated for quarrying in the bluff along the northern edge of the Meramec River flood plain. It ranges from about 80 feet above the flood plain on the west to about 50 feet above the river at the easternmost quarry. Several firms produce glass sand at Pacific.

A glass-sand quarry, about 1¼ miles east of the town, on the bank of Meramec River, discloses massive beds of sandstone separated by distinct bedding planes. Along one such plane near the top of the quarry occurs a seam of yellowish fine sandy shale one-fourth to one-half inch thick, and this shale appears also in the Frisco Railroad cut north of the quarry. Shale so rarely occurs in this formation that its presence here is worthy of note. It must be removed in the preparation of high-grade sand. In color the sand is mostly pure white, but striking variations are displayed, including shades of pink, light yellow to dark brown, and along the bedding planes near the thin shale the sand is light green. The dark-brown layers are not utilized, but the fainter-colored beds are sometimes worked in with the white sand, as the color of the resulting mixture is scarcely perceptible. There is considerable variation in the hardness of the sandstone. Toward the top of the quarry the sand is loosest, as it has little or no cover. Through the middle of the quarry face, along bedding planes, run certain hard crusts, where the sand has been unusually cemented. This cementation occurs in the whitest sand, which otherwise would be most desirable to work. Segregations of quartzite, termed "niggerheads," also occur. One bed of light-brown sand, coarser grained than the average, sparkles in the sunlight, as it has undergone recrystallization. This sand is said to be highly desirable for rock sawing, on account of its sharpness and coarseness.

From quarries north of the railroad tracks, about three-fourths of a mile east of the union station at Pacific, a large quantity of sand has been removed, and in 1905 the quarry presented a face 75 feet high by 400 feet long, capped by green sandy shale and overlying limestone. Near the top the sandstone is of a greenish color and is cross-bedded. At this quarry the sandstone is very soft and friable, breaking down under the influence of a heavy rain. This condition might render possible the hydraulicking of the deposit in a manner similar to that employed at Ottawa, Ill. The best grade of sand is obtained from the lower part of the quarry, and is used for the finer grades of glassware and plate glass; the second grade, used for window glass and fine bottles, comes from the middle beds, while the upper material is suitable for colored bottles and for jars. The extent to which this deposit has been worked brings it near the limit of profitable stripping, unless new methods of working are substituted for those common to this locality. Some sand has been obtained by excavating caves into the bluff, but owing to the looseness of the sand this method can not be depended on here unless the sand is excavated completely up to the limestone roof.

East of the union station, north of the track, at Pacific, a face of some 60 feet of sand is being blasted down and crushed, washed, dried, and screened at a mill. The sandstone extends below the quarry and may reach a total thickness of 100 feet. The variations in color mentioned above are noticeable here, the colored sand running in strips and pockets. The greater part of the prepared sand from this plant is used in the manufacture of plate glass at Valley Park, Mo. The sand is subjected to two washings, which remove a small amount of "sediment," apparently a very fine clay, and also tend to reduce the color. Even after the second washing the sediment forms a thin film on successive layers of sand in the bins. The resulting color of the prepared sand is a very light yellow, imperceptible except in large masses. Plate glass made from it shows the usual pale-green tint on broken edges.

Crystal City.—Forty miles south of St. Louis, on the Frisco Railroad, at Crystal City, the plant of another large plate-glass company is supplied with silica from its sand mines at that point. The St. Peter sandstone lies relatively low here, and only the upper 40 feet can be obtained by present methods. The openings are on the east side of a small ravine that enters Plattin Creek from the southeast. The sandstone rises about 30 feet above the floor of this ravine. It is overlain by thin sandy shale, with medium beds of limestone above. In working the sand the overlying rock was first stripped back as far as practicable, or until a thickness of about 15 feet of the limestone was reached. Tunneling into the sandstone was then begun, and in 1905 five or six openings entered the bluff into connecting chambers, which have largely been mined out for about 100 feet, with the exception of the pillars. Other tunnels extend in one-fourth mile farther, and considerable sand has been removed all the way back. The floor of the openings is about 5 feet below the bottom of the ravine, but it has been impossible to mine much below this level on account of ground water. About 25 feet, vertically, of sand are removed, leaving 6 to 10 feet as roof. The sand has not been removed entirely to the top, on account of the impurity of the upper beds, but it seems that the overlying limestone might make a good roof after some of the lower shaly layers are pulled down. This method of mining is reported to be more expensive than open-pit workings, where stripping is necessary for only a few feet.

The sand appears in general rather uniform in color, but contains a few pale-yellowish streaks and is a trifle coarser than that from the quarries farther north. Several very white streaks near the top are somewhat harder than the rest, but as the ground level is approached the rock becomes more and more friable. The product for melting is crushed, washed, and dried. An appreciable yellow sediment is removed by washing. Crushed but not washed sand is used in the factory for grinding and beveling plate glass. In this process the sand grains are made finer and finer, and the various grades are used successively, being finally replaced by emery powder and rouge in polishing. The friable condition of the sand below water level suggests that much of this material might be obtained by pumping it up into the mill.

Silica.—At this place also, 32 miles south of St. Louis, on the St. Louis, Iron Mountain & Southern Railway, is a large sand quarry in the St. Peter sandstone, where beds lower than those at Crystal City are reported to be worked.

INDIANA AND KENTUCKY.

In Indiana sandstones of Silurian, Devonian, Carboniferous, and Tertiary (?) age have been utilized for glass making, but at present the Carboniferous sandstone furnishes the greater part of the glass-sand output.

Silurian.—Rocks of Niagara age extend from the Illinois line, in Newton County, eastward nearly across Indiana and cover the upper Wabash Valley. For the most part they are buried under a great thickness of drift. These Niagara rocks consist principally of magnesian limestone of varying composition and texture, but in some localities they occur as thin lenses of sandstone. One of these lenses, near Kenneth, Cass County, 3 miles west of Logansport, is 5½ feet thick and is composed of pure white quartz sand, containing only traces of calcium carbonate and iron. Just west of the Hamilton-Madison County line, at a point 1½ miles southwest of Fishersburg, a 5-foot bed of very pure white standstone has been quarried for glass making. At this point the rock is massive, fine grained, and friable, and is overlain by less than 1 foot of buff magnesian limestone, over which lie 18 to 24 inches of surface clay. Owing to the scarcity of outcrops and the thinness of the beds the sandstone of the Niagara formation can hardly be regarded at present as a very valuable source of glass sand in this region.

Devonian.—Rocks of Devonian age, like those of Silurian age, are covered by thick drift where they occur in the northern part of Indiana, but farther south are more favorably situated. In the vicinity of Pendleton, 28 miles northeast of Indianapolis, there is a massive, soft, white sandstone, varying in thickness from 7 to 15 feet. This sandstone is sufficiently pure for use as a glass sand and has been quarried as such at Pendleton, but in general has not proved thick enough for successful exploitation.

Carboniferous.—Sandstone and shale of Pennsylvanian age constitute the country rock of the southwest part of Indiana from Ohio River northward to Benton County, for a distance of 200 miles, in which they outcrop to a width varying from 2 to 3 miles at the north and reaching 75 miles at the south. These rocks dip westward, or a little south of west, so gently that locally they are nearly horizontal. Active quarries at Wolcott in White County, Loogootee in Martin County, and Coxville in Parke County, are in Pennsylvanian rocks, the first two being in the Pottsville sandstone, sometimes called "Mansfield" in Indiana.

The Pottsville sandstone, or "Millstone grit," the basal formation of the Pennsylvanian series, doubtless is more important to the glass-sand industry than any other formation in the State. Its sandstones vary greatly in texture, color, and thickness. Locally it contains a coarse conglomerate, which grades into a coarse sandstone, and in places it consists of alternating sandy and pebbly strata. The sandstones may be massive or thin bedded, and at many places they show cross-bedding. The rock is mostly rather friable, but along bedding planes, in places where it is cemented by ferric oxide, it becomes very hard. It comprises hollow nodular masses and thin streaks of limonite and thin streaks of carbonaceous matter in all stages of alteration, from decomposed woody matter to bituminous coal, and these are accompanied by seams of fire clay. The color of the rock, where freshly broken, ranges from white and light gray, through buff, yellow, and brown, to red. The outcrop area of the sandstone is about 12 miles wide from west to east in Martin County, where the rock is well exposed by the drainage system of East Fork of White River. The beds strike in general N. 12° W., and a strip running 15 miles wide extends in Indiana from Ohio River at Canneltown, Perry County, for about 180 miles north-northwest into Benton County, where it becomes hidden by consolidated gravels, clays, and soils of Quaternary age. The Pottsville sandstone occurs in Benton, Jasper, Owen, Monroe, Greene, Lawrence, Martin, Daviess, Orange, Dubois, Crawford, Perry, and Spencer counties. Owing to its superior durability, it has expressed itself strongly on the topography, forming vertical cliffs and capping many limestone and shale hills. Its observed thickness ranges from a few feet to more than 100 feet, although 40 to 60 feet are the usual limits. In consequence of its position above ground-water level it is at most places well situated for quarrying and is also well situated as regards transportation facilities, since no less than 16 railroad lines cross its area of outcrop in Indiana.

A Pennsylvanian sandstone of later age than the Pottsville is worked extensively for glass sand at Coxville, Parke County. The geologists of the Indiana survey regard this rock as the filling of a valley or channel carved in the "Upper Coal Measures." It appears to be younger than coal "VI" and older than coal "VII," and may correspond to the Merom sandstone of Sullivan County. Other evidences of filled channels have been observed in Parke and Fountain counties, and in Vermilion County, Ill., and these channels have been tentatively referred to the drainage system of the "Coxville Carboniferous River."[1]

Tertiary (?).—Deposits of sand, gravel, and, in places, conglomerate occur on the high points of the upland bordering the Ohio River flood plain in Indiana and Kentucky. G. H. Ashley [2] mentions their occurrence in Spencer, Perry, Harrison, Washington, Floyd, and Clark counties, Ind., and the writer has observed deposits of a similar nature in Hardin County, Ky. As these fragmentary deposits are associated with an old peneplain and are evidently younger than Carboniferous and older than Quaternary, they are regarded by Ashley as of Tertiary age. These beds consist of white, yellow, red, and brown sand and soft sandstone, and farther south they attain a thickness in places of more than 50 feet. The grain of the material grows coarser from south to north, and the thickness of the deposits decreases notably toward the north. Beds of various colored clays are found at or near the bottom of the deposits. Sands belonging to this series of deposits have been dug for glass material at De Pauw and New Albany, Ind., and are now being exploited at Tip Top, Ky.

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[1] Ashley, G. H., The coal deposits of Indiana: Twenty-third Ann. Rept. Dept. Geology and Natura Resources Indiana, Indianapolis, 1898, pp. 80, 300, 345, 378, 385, 386, and 406.

[2] Ashley, G. H., and Kindle, E. M., The geology of the Lower Carboniferous area of southern Indiana Twenty-seventh Ann. Rept. Dept. Geology and Natural Resources Indiana, Indianapolis, 1903, pp. 68-70

Maps and publications.—The United States Geological Survey has not yet issued topographic or geologic maps of these areas, but the Indiana Geological Survey has thoroughly covered the ground in that State, and much information may be obtained concerning the sandstones from the twentieth, twenty-first, twenty-third, and twenty-eighth annual reports of the Indiana Survey, the latter containing a State geological map.

OHIO.

Sandstones of Silurian and Carboniferous age are at present being exploited for glass sand in Ohio.

Silurian.—Interbedded in the limestones of the Monroe formation[1] ("Lower Helderberg" or "Waterlime") are a few beds of extremely pure silica sandstone that have long been known to outcrop in northwest Ohio, in Lucas and Wood counties, and in Monroe County, Mich. The quarries at Sylvania and Holland, Ohio, are in this sandstone. Silurian limestones occupy fully one-third of the area of the State and contain lenses of sandstone at some places, as in Champaign and Logan counties.

Carboniferous.—Sandstones covering a wider range in geological position than those available in the Silurian occur in the Carboniferous system in Ohio. The lowest beds utilized belong to the Blackhand formation of the Mississippian series, and are worked at Blackhand, on Muskingum River, below Newark. Other localities in which Mississippian sandstones are worked are at Rockbridge, Hocking County, and at Akron.

Rocks of early Pennsylvanian age, belonging to the Pottsville formation or "Conglomerate group," are widespread and are worked for glass sand at Chalfants and Niles. The "Massillon" sandstone member of that formation, quarried at the city of Massillon, is also a source of supply. Sandstone still higher in the system, or in the "Lower Coal Measures," is another source of glass sand. Topographic maps of the Akron, Massillon, and Toledo quadrangles are issued by the United States Geological Survey, and the Ohio Geological Survey has issued geologic maps showing, in a general way, the distribution of the rock formations in this State. Among the most useful of these are the atlases accompanying Volumes V, VI, and VII, as well as a small-scale map in Volume VIII and the large atlas sheets issued in 1879.

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[1] Lane, A. C., Rept. State Board of Geol. Survey for 1891-92, Lansing, Mich., 1893, p. 66.

INDIANA.

Coxville.—At Coxville, about 2 miles northwest of Rosedale, a station on the Vandalia line, 16 miles northeast of Terre Haute, glass sand is produced. The sandstone quarried here is a deposit filling an erosion channel in the "Upper Coal Measures." The sandstone is exposed to a height of about 40 feet above the flood plain of Raccoon Creek. The base of the deposit is not exposed in the quarry, but overlies shale and coal "No. VI" at the margins of the channel, which are some 600 feet apart. The beds are massive, lie nearly horizontal, and are covered by a few inches to nearly 10 feet of drift clay containing bowlders and gravel. This sand is rather soft, o medium-sized, angular grains, and the mass ranges from white t light brown in color. Close inspection shows that certain beds are speckled with iron-oxide spots the size of a pin head, so closely spaced that 30 or more spots appear in a square inch of surface. The sand is slightly micaceous and the bed contains occasional clay streaks When crushed and dried the average sand has a light yellowish-brown color, due to impurities, a large proportion of which might b removed if the product were washed. The process of treatment i simple. After the customary drilling and shooting down, the broke rock and loose sand is loaded into the mill by a steel bucket on cable conveyer and dumped directly into a Blake jaw crusher. Th material then passes through one set each of corrugated rolls an smooth rolls and is thus separated into its individual grains. A bel conveyer, elevator, and chute, in the order given, carry the sand t a rotary drier burning coke. From the drier the sand may be delivered directly to cars or stored in bins. The quarry is fairly well situated with respect to transportation facilities, having direct connections with the Chicago & Eastern Illinois Railroad, and switchin connections at Rosedale with the Vandalia line. The market for thi sand consists chiefly of glass works in the State that make beer bottles. Some of these works are at Terre Haute. Without washing th sand is not satisfactory for flint and window glass. It is, however, i great demand for furnace use. Its analysis is shown on page 42.

Loogootee.—A glass-sand quarry is operated in Martin County, 1 miles east of Loogootee, on the Baltimore & Ohio Southwester Railroad. The Pottsville sandstone occurs in this vicinity in it typical development, forming the bluff of Boggs Creek, about 50 fee high, and it is reported to be nearly 100 feet thick, as determined b drill. A face of 25 feet above the railroad level is open in the quarry disclosing masses of cross-bedded white to brown, rather coarse, sof sandstone containing a thin bed of fine quartz pebbles. Thin lense of dark iron-cemented sandstone are common and in places iro oxide has been segregated to such an extent as to form lenses 1 foo thick. Streaks of carbonaceous matter further increase the pe centage of impurity in the deposit, and joint planes enlarged to a widt of 6 inches are filled with clay from the surface. All these objectionable substances, constituting about 5 per cent of the quarried material, may be separated by hand.

The best grade of sand is used at Loogootee for common bottl and fruit jars. Other grades are used for molding, and some goes t the large lime quarries at Mitchell and Bedford for stone sawing. The quartz pebbles, separated by screening, are reserved for sale separately.

Wolcott.—The quarry at Wolcott, formerly operated by the American Window Glass Co., was not visited by the writer, but E. M. Kindle has made mention of it as follows:[1]

> Just west of Wolcott the Mansfield sandstone appears at the surface. It is extensively quarried for glass making in the southwest quarter of section 25. The section exposed in the quarry shows:

	Ft.	in.
Surface clay	6	8
Light bluish gray, coarse sandstone with quartz pebbles scattered through it	25	

> The sandstone is very friable and in part of the quarry is but little more than an unconsolidated sand.

KENTUCKY.

Tip Top.—A sandpit was in operation in 1906 at Tip Top, Hardin County, 28 miles southwest of Louisville, on the Illinois Central Railroad. Post-Carboniferous sand, probably of Tertiary age, was obtained here from a deposit occupying the highest points of the upland surface and reaching elevations of 400 feet above the mean level of Ohio River. The deposit here attains a thickness of more than 50 feet and covers 40 or more acres. It consists of massive sandstone, so soft and so poorly cemented that it crumbles when touched. The sand is mainly white and yellow, the yellow sand constituting the upper three-fifths of the deposit. Along joints the yellow sand has been stained deep red by infiltration of a fine red silt from the surface. The lowest beds exposed in the quarry are of pure white, very fine grained, clear quartz sand, and interstratified with them are a few lenses and bands, 2 to 6 inches thick, of yellow and white plastic clay. At the lowest point excavated in the quarry a reef of fossiliferous chert has been uncovered, but this was not visible at the time of the visit. Deep drill holes within one-half mile of the deposit do not encounter any such beds as are here exposed, and thus tend to confirm the belief as to the fragmentary nature of the deposit. The acreage of sand available, however, has proved to be large enough to warrant the erection of an efficient plant for procuring and washing the product.

The hydraulic method, so successfully used in the Ottawa, Ill., glass-sand district, was employed here at the time of visit to remove the sand from the pit. The material is so slightly indurated that a jet of water from the nozzle of a large hose is sufficient to break it down, free it from the interbedded clay, and wash it into the sump of a Nye pump at the lowest point in the pit. The pump raises the sand about 12 feet to a screen having $\frac{1}{8}$-inch meshes. The screened sand drops through the chute into a tank, from which it is carried by a gently inclined elevator out of the pit into the first set of wash bins. The washers consist of 2 sets of 2 bins each, the bins of the first set holding about 25 tons each, those of the second holding about 40 tons each. A second elevator carries the sand to the second set of bins, from which a second Nye pump moves the sand to the drain bins. The sand is not subjected to any further drying. The drain bins are used for storage purposes and are built alongside a railroad spur. They consist of 3 bins of 50 tons capacity each and 3 of 40 tons each, making convenient measures in loading cars. They are built of 2 by 6 inch lumber, laid flat, and have a basal compartment 8 feet deep, filled with cinders to insure rapid drying. Owing to the upland location of this quarry water is scarce, and the problem of maintaining a steady and adequate water supply has been solved satisfactorily by utilizing the waste waters from the washers after thorough settling, the loss from evaporation and seepage being replenished by piping a supply down from a pond about one-third of a mile distant. The dissected topography has favored the construction of storage and settling bins. It was planned to install steam driers in order to increase the capacity of the plant and to furnish the sand in better condition. The white and yellow sands are worked up together, and after washing make a light-colored, clean quartz sand, suitable for good grades of glass. When prepared by itself the white sand is of very high grade, while the deep red clay sand makes an excellent molding material. This glass sand was mostly used by the flint and bottle houses at Frankfort, Ky. Analyses of this sand are given on page 42.

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[1] Kindle, E. M., Stratigraphy and paleontology of the Niagara in northern Indiana: Twenty-eighth Ann. Rept. Dept. Geology and Natural Resources Indiana, Indianapolis, 1904, p. 417.

OHIO.

Sylvania.—Glass sand is quarried about 4 miles southwest of Sylvania, a station on the Lake Shore & Michigan Southern Railway, 10 miles northwest of Toledo. Sandstone and dolomite are obtained in neighboring quarries from beds of the Monroe formation. In the Ohio Survey reports the sandstone is termed the Sylvania sandstone, and the limestone the Lucas limestone. The rocks are covered by only a thin veneer of drift, a few inches to 2 or 3 feet thick. The surface of the country is flat and the rocks are quarried from two large pits trending north-south, or with the strike of the rocks. The beds dip about 5° to the west, the sandstone underlying the dolomite and outcropping on the east of it. The sandstone quarry to the east was 15 to 25 feet deep and covered about 2½ acres in 1906. The dolomite quarry had been excavated to about the same depth and covered about twice the area of the sand quarry. Numerous springs emerge near the bases of the quarries and are drained by ditches into water holes, which are emptied by 6-inch pumps. Between the two pits stands the sand mill, with its necessary trackage, and west of the dolomite quarry stands a mill for crushing that stone. Both quarries are operated on the same plan. The sandstone is a grayish to white, firm rock, in thin beds, having a total thickness of 15 to 25 feet. At the base of the sandstone lies a conglomerate of dolomite pebbles in a sandstone matrix, below which is a bed of hard, fine-grained, dove-colored dolomite with an uneven surface. At the top the sandstone has in places received a slight yellowish stain. Its grains are rather fine and under a field lens appear to be of clear quartz, for the most part worn smooth. On the whole, the sand is a very light-colored, clean material. Compressed-air drills are used, and the sand is blasted and loaded into trams that are moved by gravity over tracks that converge at a turntable. The cars are drawn up an incline by cable into the mill, where they dump into a Blake crusher. When crushed the sand passed through three sets of rolls, was washed twice by the "auger" method, was screened, dried by steam coils, screened again, and stored. From the stock house the sand was delivered through pipes into cars. This sand is shipped for glass making mainly to Ohio, Indiana, and Pennsylvania factories. An analysis of the sandstone is given on page 625.

The dolomite is not burned, nor sold as building stone, but is all crushed and used as fluxing material.

Holland.—Near Holland and Monclova, about 10 miles west of Toledo, sandstone and dolomite of the Monroe formation lie near the surface, as at Sylvania. About 2½ miles southwest of Holland are the quarries where glass sand was formerly obtained, crushed, screened, cleaned by fan draft, and shipped to the glass factory at Maumee. The beds have a low dip to the west and in a generalized section are stratified as follows:

Generalized section near Holland, Ohio.

	Feet.
1. Glacial drift, clay, pebbles, and bowlders	0– 5
2. Dolomite, dense, fine-grained, in thin beds	10±
3. Sandstone, grayish-white, friable, of fine, rounded grains	15±
4. Dolomite, very hard, siliceous	2
5. Sandstone, similar to No. 3, bottom not visible, reported thickness	60

At the time of visit mills and quarries were closed for the winter and the old sandstone pit was filled with water. The sand appears to be of good grade, and as the quarries are connected with the Lake Shore & Michigan Southern main line by a well-constructed spur it is probable that the production of glass sand will at some time be resumed.

Toboso.—A large quarry is operated for glass sand one-half mile west of Toboso, a station on the Baltimore & Ohio Railroad, about 15 miles east of Newark. The quarry is in sandstone and conglomerate beds that outcrop in bluffs about 60 feet high on the right bank of Muskingum River. About 30 feet of sandstone were worked in 1906 after stripping the top 5 to 20 feet, which was of thin-bedded and shaly sandstone. The quarry can be worked probably to river level, about 15 feet lower, since the rock contains very little water to that depth. The fresh quarry face presents on the whole the appearance of a uniformly yellowish-brown sandstone. The rock is massive, cross-bedded, rather coarse-grained, and contains many layers of fine to coarse quartz pebbles. Some of these pebbles attain a diameter of three-fourths inch. A few streaks of white sandstone occur, composed of clear quartz and white, opaque quartz grains with a sprinkling of fine black specks, mainly of tourmaline and hornblende. Rarely there are seams, 2 to 4 inches thick, of siliceous iron ore and a few thin clay seams. The sand is drilled by steam, shot down, and loaded into skips, which travel on trucks to the middle of the quarry, where the skips are picked up by cable conveyer and carried to the mill. This cableway is about 900 feet long and well illustrates the efficiency of this method of handling sand. The sandstone was reduced first by a jaw crusher, next by a 16-hammer Williams mill, was next screened, and then ground in a wet grinder, or vat, in which two heavy iron rollers or "chasers" revolve at the ends of an axle. Washing was accomplished by two sets of "augers," each set consisting of two screws 10 feet in length, which carry the sand up inclined troughs against a flow of water. Water for washing was obtained from Muskingum River, which at times is very muddy. When finished the sand is of a light brownish-yellow color, evidently containing a high percentage of ferric oxide as compared with most glass sands. The whole output was used by the American Bottle Co., at Newark, in the manufacture of green and amber bottles. The quartz pebbles or gravel, separated in screening, constitute an important by-product of the sand and are sold for sand blasting.

Chalfants.—Glass-sand quarries are operated at Chalfants, Perry County. The sandstone utilized at Chalfants lies high in the bluff, 125 feet above the Baltimore & Ohio Railroad track. The rock is a light grayish-yellow sandstone, massive at the base but becoming thin-bedded at the top, and about 35 feet thick. A few layers contain small, rounded quartz pebbles. The sandstone is underlain and overlain by clay, the upper clay, 3 to 10 feet thick, forming the surface of the hill. About 2 feet of sandstone is left at the base for a floor. The next 20 feet of beds are easily crushed and worked into glass sand, while the upper 10 to 12 feet, which is a very fine-grained material, indurated nearly to a quartzite, is crushed and mixed with the overlying clay to form ganister. The rock was lowered to a mill at the base of the hill by a cable incline, or tramway, crushed, screened, washed by "augers," and dried in a rotary drum. Of the finished product the glass sand goes to window and bottle plants in central Ohio, and the ganister and pebbles are mainly taken by steel mills in Detroit, Mich.

It is probable that a vast amount of good material is still available in the sandstone of Licking, Muskingum, and Perry counties.

Massillon.—At Massillon glass sand is derived from the "Massillon" sandstone member of the Pottsville formation. About 40 feet of grayish and buff-colored sandstone are exposed. The rock of the lowest beds is coarse grained and at some places has been used for making grindstones. The middle beds are fine to medium grained, and the upper beds in places grade into shale. Shale underlies the sandstone and clay overlies it. Quarries at Massillon are among the oldest in the State, having been opened nearly 75 years ago. The preparation of the sand is accomplished in a very compact and efficient mill. The process employed in 1906 comprised crushing, rolling, screening, and drying. The drying was effected by two 16-foot double-draft rotaries, which burn natural gas. The sand was then elevated to cooling drums, where the fine dust was drawn out by fans. This method of removing the dust is supposed to obviate the necessity of washing the sand. The finished product is a light-yellow, fine to medium-grained, partly angular sand. It is used mostly in Massillon by manufacturers of green and amber bottles. An analysis of the sand is given on page 625.

In addition to glass sand, fire and furnace sand and an even-grained, pink sandstone for building purposes are produced from the "Massillon" sandstone.

Small quantities of glass sand and larger quantities of sand for metallurgical purposes are produced at Barrs Mills, Dundee, and Strasburg, Tuscarawas County; Twinsburg, Summit County; Warwick, Wayne County; Killbuck, Holmes County; and Layland, Coshocton County, all in east-central Ohio.

Akron.—A sand quarry is located about 3 miles northwest of the center of Akron, on the line of the Northern Ohio Railway, on the brow of a scarp overlooking the valley of Cuyahoga River. At this place 12 to 20 feet of fine-grained, sharp, gray to buff sandstone above and 16 feet of pebbly conglomerate below are utilized.

At the time of visit the sand was crushed, rolled, screened, and dried, and was all sold for steel making, while the coarse pebbles from the conglomerate were used for concrete work.

Niles.—A large sand quarry and mill were in operation in 1906 about 4 miles south-southwest of Niles, near Austintown, on the Erie Railroad. Sandstone of Pennsylvanian age was quarried here from a large, open cut 25 feet deep. The face showed 8 feet of yellow to reddish sandstone at the top, with 15 feet of gray to white sandstone below. The beds have a slight dip to the north and are composed of a moderately coarse, subangular quartz sand, showing cross-bedding and containing in places near the base of the quarry some carbonaceous material in streaks and bands, one of which reaches 6 inches in thickness. The sand was sorted in the quarry and four grades were produced. The three best grades were sent to glass factories in Pennsylvania, principally for window glass, and the fourth-grade sand was sold for furnace and mill purposes. A symmetrically arranged mill completed the preparation of the sand, which passed in turn through a high-speed jaw crusher, a wet grinder, a reel screen, three sets of "auger" washers, further screens, and then was pumped through a delivery pipe to various places in the large drain room. The floor of this room was constructed of coarsely crushed rock covered by mineral wool. The sand was dried in a stationary roaster, the essential parts of which were (1) an uncovered oblong, iron box, roughly estimated at 7 feet wide, 25 feet long, and 2 feet deep, fitted with a bottom of grate bars; (2) a fire box directly below the grate, but separated from it by a slanting sheet or plate of iron.

The sand was dropped from the belt into the open box, the capacity of which was about 25 tons. While drying it sifted slowly through the grate at the rate of 3 tons an hour, fell on the hot, inclined plate above the fire, and slid out on a screw conveyer operating in front of and at the base of the drier. After one more screening the sand was stored ready for shipment.

Glass sand is reported to be produced at Leavittsburg, Trumbull County, about 10 miles northwest of the Austintown quarries.

WEST VIRGINIA.

The deposits of pure quartz sandstones occurring between Hancock, Md., and Berkeley Springs, W. Va., have been quarried for many years, but it is only within the last years that mining operations have become active.

Geology.—The sand is derived from a white sandstone composing the Warm Spring Ridge in West Virginia, which runs south-southwest from Potomac River opposite Hancock, Md. This formation is the Oriskany sandstone and is part of a monoclinal series of beds between a massive anticline bringing up sandstone of Medina age in Cacapon Mountain, 1½ miles to the west, and a sharp syncline of Carboniferous rocks forming Sleepy Creek Mountain, 6 miles to the east. The rocks strike N. 10°–25° E. and dip 50° SE. On the west, beneath the sandstone, are limestones of Helderberg age and shales of Cayuga age. Above it, on the east flank of the ridge, is a belt of black shales of Marcellus and Hamilton age, followed by rocks of Chemung age.

Character of the sand rock.—The sandstone of this ridge is of exceptional purity. In other outcrops of this formation to the east and to the west, where it is brought to the surface by folding, it is commonly a siliceous limestone with chert nodules and fine conglomerate. The pure sand rock seems to be limited to a few miles in length along the strike of the Warm Spring Ridge, for northward in Maryland it changes to a yellow, impure, and coarse sand rock, suitable only for building sand. Its extent southward has not been determined. It is mined as far as Berkeley Springs, the end of the railroad spur up the Warm Spring Valley, but the same character of rocks at the surface seems to continue far beyond, and the land is held largely as sand land, its development awaiting the extension of the railroad.

This pure white quartz sand is evidently a beach or near-shore deposit, and its purity, freedom from mud and other fine detritus, the uniform size of its particles, and their subrounded character indicate long-continued sorting action at this part of the shore. The grains are of medium fineness, practically all passing a 40-mesh sieve and 25 per cent passing a 60-mesh sieve. Particles of milky cryptocrystalline silica are scattered among the grains; whether these are original chert fragments or were deposited there from solution is not known. The grains are loosely cemented by lime, the Berkeley Springs water, which issues from the upper beds of this formation, containing a small percentage of carbonate of calcium. At the surface the rock is hardened and slightly glazed, apparently by the solution and redeposition of silica between the grains. In depth, however, the rock is commonly soft, breaking into grains in blasting or from the use of the sledge hammer.

Notes on mines and quarries.—The oldest mine is located near the north end of the ridge. This mine is but 2 miles from Hancock. It is located on the top of the ridge, where the edges of the sandstone beds outcrop in rocky ledges 300 feet above the Baltimore & Ohio Railroad track along the river at the west foot of the ridge. This mine was established before the branch railroad up the Warm Spring Valley was built, and the only direct railroad communication was by the main line to the west. The western side of the ridge is composed of Helderberg limestone, through which a tunnel had to be constructed to reach the sandstone on the eastern side. The mine is a large open cut, 120 feet deep, about 130 feet wide, and 400 feet long At its south end is a tunnel in which much rock has been quarried but this method of mining has been abandoned and the whole width of the ledge is now being worked as an open cut.

About 150 feet of rock are exposed in the quarry and most of this is available for glass sand. The total thickness of the formation is probably about 170 or 180 feet. The upper part is a hard bed 20 feet thick, which is not mined, but is used as the east wall of the hole On account of the steep eastward dip it overhangs and is to some extent a source of danger, as in places it has caved in. The sandstone as quarried varies from pure white to creamy and is generally fine grained with an occasional coarse bed. Below the surface it crumbles on being quarried, and the sand is handled largely by shovel. Large lumps are readily broken with a sledge hammer, and the few masses from harder beds which do not yield to this treatment are thrown aside and not utilized, as this company does not use a rock crusher. The rock is drilled by steam, the power plant being located on the old floor of the quarry on the level of the tramway tunnel. The quarry has since been carried 30 feet below this level, which necessitates a cable tram to haul the loaded cars to the grade of the tunnel. On account of the inclosed character and the depth of the quarry the heat becomes unendurable in the summer, and a canvas awning is suspended over the workmen to shield them from the sun.

From the mouth of the tunnel, 200 feet above the railroad, a narrow-gage railroad runs to the mill at the river, three-fourths of a mile north. The grade on this tramway is sufficiently gentle for mules to haul the empty cars over it, but a small locomotive has been installed. At the mill the sand and rock are passed through a roller or mull and then washed and dried, the product being a pure white quartz sand, suitable for making table, window, and plate glass. The capacity was reported to be 200 tons a day. The mill was destroyed by fire early in 1905, but has since been rebuilt.

The other mines on this ridge are all located on the eastern flank along the Warm Spring Valley. The construction of the Berkeley Springs Branch of the Baltimore & Ohio Railroad from Hancock to Berkeley Springs made the eastern part of the Warm Spring Ridge accessible to the railroad and was the cause of the recent rapid development of the glass-sand industry.

The southernmost opening on the ridge is at the northern edge of the town of Berkeley Springs. The quarry, like all those on the eastern side of the ridge, is midway on the slope, about 150 feet above the valley bottom, and near the base of the sandstone exposure. It is an open cut 200 feet long by 100 feet across and 50 or 60 feet deep. It is entered by a short tunnel through the harder cap rock forming the eastern face, which is not quarried here. The rock appears to be of excellent quality and has furnished a high grade of sand. A cable tramway leads to the mill in the valley.

Another set of quarries is located one-half mile north of the quarry just described. These quarries are 200 feet above the valley. The older opening was about 100 feet square, exposing throughout white rock somewhat harder than that at the first-mentioned mine. The cap rock is hard, coarse, and somewhat impure, but is mined and, together with 10 feet of surface stripping and weathered streaks where the sand is stained yellowish, makes a second grade of sand, used for bottle glass and railroad sand. Ninety per cent of the rock produces sand of No. 1 grade, pure white, and containing over 98 per cent of SiO_2. This is used for plate and window glass and tableware. The very choicest is reported to run 99.8 per cent SiO_2 and is used for the finest cut glass.

The stone is drilled by compressed air and is brought to the mills in the valley by two double-track gravity cable tramways. The material is assorted at the quarries and the surface rock and other second-grade material is sent to the old mill for treatment. The better grade rock is taken to the new mill on elevated tracks and dumped into chutes which lead directly to two mulls, the larger fragments being first sorted out and run through a Blake crusher. In the mulls, which are circular vats in which revolve two heavy iron wheels at the ends of an axle, it is crushed wet, until it will pass through a fine screen into the washers. These consist of long, inclined boxes in which large screws revolve, and the sand is churned and cleaned as it is carried upward by the screw against a flood of water down the box. The tailings are deposited in settling yards and make good building sand. The washed sand is conveyed by horizontal continuous belts to the drying room or to temporary bins on the way. The drier is a slowly revolving inclined cylinder over a fire box. The hot, dry sand is delivered at the lower end into cups of an endless chain, which carry it out of the building to elevated iron storage tanks on concrete piers, ready for loading by gravity. Every precaution against fire is taken in this modern plant, since the former mill was destroyed by fire from overheated sand deposited in wooden bins. The capacity of the two mills is 10 car-loads of 30 tons a day, and the average shipment is reported to be 6 cars.

In the summer of 1905 two new quarries were opened and two new mills were being erected within a mile of the quarries just described. The company is said to have bought up nearly all the property between Berkeley Springs and Hancock.

In the town of Berkeley Springs a pulverizing mill is operated at which some of the highest grade of sand is pulverized for use in porcelain, china, and glazed-brick manufacture.

In 1904 a sand mine was opened on the west side of Cacapon Mountain, 1½ miles west of Berkeley Springs. This mountain is composed of sandstone of Medina age, the core of the massive anticline previously referred to. The opening is along the Berkeley Springs-Great Cacapon road, on the west crest of the ridge. A hole 20 feet wide and 150 feet long had been quarried into the face of the hill, exposing low westward-dipping beds of hard quartzitic sandstone somewhat stained with iron. The quarry is admirably located for handling the product by gravity 500 feet down the slope, on a grade of about 70°, to the railroad. At the bottom of the incline a mill has been constructed with the different compartments arranged in terrace form, utilizing gravity in crushing, washing, drying, and storing the product ready for loading on the cars. The rock is so hard, even at the depth attained, that it must all be crushed and thoroughly ground, and even then it does not separate into grains, but breaks into fragments of various sizes, much being reduced to a powder. The product, therefore, is not so suitable for high-grade glass, and the greater amount of grinding necessarily adds to the cost of production. The surface appearance of the rock is also not favorable, as it has a grayish cast with numerous iron stains, but an analysis was not obtained and its exact composition is not known.

Other sand quarries.—At Hancock, on the Maryland side of the river, the Warm Spring Ridge sand rock is quarried, but is coarse and impure and furnishes only a low grade of yellow sand for building purposes. This was extensively used by the Western Maryland Railroad in the concrete work along its new extension to Cumberland. A similar building-sand quarry is located opposite Great Cacapon, W. Va., 8 miles up the river, where the same Oriskany sand rock outcrops on the other side of the Cacapon Mountain anticline mentioned above. This rock appears to be of better grade than that at Hancock, but is much harder. The product was largely used in the construction of the same railroad.

UNDEVELOPED RESOURCES.

GENERAL STATEMENT.

The St. Peter sandstone, the formation furnishing most of the material now being exploited in the Middle States, has a very wide extent. It outcrops in the Mississippi Valley in the States of Minnesota, Wisconsin, Iowa, Illinois, and in northeastern Missouri, and also at places in the Ozark uplift in Missouri, Arkansas, and Oklahoma. Wherever it has been recognized it usually presents the same characteristics, viz, massive beds of very friable sandstone, having a total thickness ranging from 25 to possibly 300 feet, composed almost entirely of well-rounded, translucent quartz grains of slight variation in size. These features, so persistent throughout its extent, render it of value as a glass sand. Consequently, wherever this rock occurs it may contain the substance at least of a glass sand. Locally the sandstone has been observed to be badly iron stained, also indurated to quartzite, both of which conditions render it of little value for glass making in comparison with the abundant unchanged material. In northern Arkansas the St. Peter sandstone has been found to contain a lens of dolomite, but even under this circumstance either or both the overlying and the underlying sandstone may be of workable thickness. Aside from the St. Peter, there are other formations in this region containing beds of sand that, under certain conditions, may prove of value as glass material. Chief among these are Ordovician sandstones older than the St. Peter, the Devonian and Carboniferous sandstones present in northwestern Arkansas and southwestern Missouri, Carboniferous sandstone in Indiana and Ohio, the "Buxton formation" in the Independence and Fredonia quadrangles in southeastern Kansas, the Cambrian sandstones ("Potsdam" or Jordan) in the Wisconsin and Mississippi valleys in Wisconsin and adjoining portions of Iowa, the Hartselle sandstone member of the Bangor limestone in Alabama, beach sand of Quaternary age on the Gulf coast of Florida, river alluvial sand on the Piedmont Plateau and Coastal Plain of the south Atlantic States, and Cretaceous sandstone in the middle Missouri Valley.

The following notes emphasize the wide range in both geologic age and geographic distribution of suitable glass sand:

ALABAMA.

Near Gate City, on the east side of Red Mountain, the strata heretofore mapped as the "Oxmoor shale and sandstone phase" by the Alabama Geological Survey, composed of sandstone and beds of shale, have an outcrop width of 1,000 feet on both sides of Red Gap. They are nearly 200 feet thick, and include one sandstone bed (the Hartselle sandstone member of the Bangor limestone) about 75 feet thick. The beds dip southeastward at an angle of about 10°. They are of Mississippian age. The Hartselle sandstone is composed of relatively pure quartz sand having very fine, subangular grains, which appear nearly white in mass. The rock is very soft, breaking down and crushing easily. Quarries which are worked intermittently for mill sand have been opened on both sides of Red Gap. About 20 years ago a small bottle plant operated at Gate City demonstrated that this sand was suitable at least for common bottles and fruit jars. It has been used also by the Dixie Glass Works, at Tallapoosa, Ga.

Gate City, just on the outskirts of Birmingham, is on the line of five railroads which enter Birmingham by way of Red Gap, and is therefore favorably situated with regard to material, fuel, transportation, and market. No glass factory can be operated as many months of the year at this latitude as can those in the North, but if window glass could be made from this sand there is little doubt that it would find a ready market.

About seven-eighths mile northeast of Trussville, a station on the Alabama Great Southern Railroad, 15 miles northeast of Birmingham, sand quarries utilize the Hartselle sandstone, as well as a reddish loam that overlies it. This loam may be of late Tertiary age. The characteristics of the Hartselle sandstone here are similar to those of the beds at Gate City. Analyses of samples of this sandstone taken at both localities are given on page 629. At present the silica sand, with an admixture of the red loam, is shipped in large quantities to mills at Birmingham, Bessemer, Ensley, and New Decatur, Ala., where it is used for molding purposes.

At North Birmingham the Lookout sandstone, of early Pennsylvanian age, is quarried for sand-lime brick making. Certain beds of this sandstone might prove pure enough for glass. The rock is of coarser grain than the Hartselle, but is very firmly cemented and is consequently harder to crush. Its chemical composition is shown on page 629.

ARKANSAS.

In the north-central and northwestern part of Arkansas, particularly along the valley of White River from Batesville nearly to Fayetteville, exposures of the St. Peter sandstone (Ordovician) and Sylamore sandstone member of the Chattanooga shale (Devonian) are common. Those deposits that face the river between Batesville and Cotter, on the White River Branch of the Missouri Pacific Railway, are in many places admirably situated for economical quarrying and transportation, and so far as a cursory examination would indicate they are of an excellent grade of glass sand. Since the above note was first published, the deposits near Guion have been opened, and some glass sand has been shipped to factories in Kansas and Oklahoma, it is reported. Survey publications relating to this region are as follows: Batesville, Mountain Home, Mountain View, Yellville, Eureka Springs, and Fayetteville topographic maps; Zinc and lead deposits of northern Arkansas (Prof. Paper No. 24), 1904, and Fayetteville folio (No. 119 of the Geologic Atlas of the United States), 1905. The St. Peter sandstone (mapped as "Key" in the Yellville quadrangle) is frequently of suitable quality. Near Everton, on the east side of the valley of Clear Creek, is a bed 25 feet or more thick of good white saccharoidal sandstone, so situated that it will not require much stripping and also convenient to the railroad. Analyses of this sandstone appear on pages 627–628 (No. 9), and show it to be of desirable quality. The Sylamore sandstone, mapped in the Fayetteville quadrangle, along White River, is within 5 miles of the railroad at Rogers and adjacent to a railroad at Sulphur Springs.

FLORIDA.

The unusual cleanness and even grain of the Gulf beach sand at Pensacola, Fla., suggested to the writer, several years ago, its suitability for glass making, and analysis of this sand (see p. 630) shows that it possesses the requisite purity. The sand is slightly coarse, the greater part of it passing a 20-mesh sieve, but not 40-mesh. Although at present remote from any glass-making centers, the deposit is not far from lines of rail and water transportation. More recently samples of white sand of a high degree of purity have been sent to the Survey from Tarpon Springs. Some of this sand is rather too fine for the manufacture of glass, but by screening a grade sufficiently coarse may be obtained. This sand appears to be in part angular. Production was reported from this deposit in 1911.

GEORGIA.

The rare use of a river sand for glass making is reported from Augusta, Ga. Sand obtained along Savannah River is shipped to Chattanooga, Tenn., where bottles are successfully made from it. The sand is composed of fine to coarse angular grains of quartz, both clear and milky varieties being present. In mass it has a light gray or dingy white color.

IOWA.

The "Potsdam" sandstone (Cambrian) and the St. Peter sandstone (Ordovician) occurring along Mississippi River in northeastern Iowa contain sand of good quality for glass making, but in the localities along the bluffs of Mississippi River north of Dubuque where they outcrop it is doubtful if they can be exploited except by mining, on account of the heavy cover of superincumbent limestone, dolomite, and shale.

The Dakota sandstone (Cretaceous) is present in the northwestern part of the State in quantity and purity sufficient to make it a possible source of sand for making bottle glass. It outcrops in bluffs along Floyd River valley northeast of Sioux City, and has been quarried for building and molding sand near the Springdale station of the Sioux City-Leeds trolley line. Between 35 and 40 feet of massive, cross-bedded, soft sandstone with thin clay partings are exposed. The top is overlain by 10 to 80 feet of loess. The sand is a fine to medium grained quartz, rather angular, and carries a small proportion of mica flakes. Its color ranges from pure white through gray to yellow and dark brown. The average is light yellow. Where iron stained the objectionable material is usually hard enough to be thrown out in blocks. Generally the rock is so friable that it could conveniently be worked by hydraulic methods. This sandstone is well situated for quarrying and transportation, as it is close to the tracks used jointly by the Chicago, St. Paul, Minneapolis & Omaha and the Illinois Central railroads. The Dakota sandstone is exposed also at the base of Prospect Hill in the Missouri River bluffs, and the top of the formation is low in the bluffs of Big Sioux River, opposite Riverside Park. Fuller descriptions of the Cretaceous sands, clays, and limestones of this region and a map of their distribution is given in a local publication.[1]

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[1] Burchard, E. F., Geology of Dakota County, Nebr.: Proc. Sioux City Acad. Sci. and Letters, vol. 1, 1904, pp. 135-184.

KANSAS.

The topographic maps of the Iola, Fredonia, Independence, and Sedan quadrangles include the area here considered. The areal geology of the Independence quadrangle was mapped in 1904 by F. C. Schrader, who makes the following statement:[1]

> In a number of localities along the western side of the Independence quadrangle, in the Buxton formation, sandstone occurring in bodies of from one-eighth to one-half mile in extent is of such purity, fineness, and evenness of grain as to give promise of usefulness in the manufacture of glass. The best quality occurs in heavy beds in which the rock has been least affected or stained by the leaching of descending surface waters. Exposures occur 4 miles northwest of Caney and 2 miles north of Caney. At the latter locality the long hill is capped by sandstone having a thickness of at least 10 feet. Other exposures occur farther north. Perhaps the best is in the southern part of Fall River Township, in the SE. ¼ sec. 22, about 4 miles southwest of Fredonia. Here the rock is exposed over an area of 10 or 15 acres, and as nearly as can be judged from some local prospecting that has been done and from the topography, it is about 12 feet in thickness.

Samples of this rock were taken in October, 1905, from each of the localities mentioned and were analyzed in the laboratory of the Survey, with the results, Nos. 1–8, page 628. Other exposures of the formation in the vicinity of Fredonia were also sampled.

At a point 2 miles north of Caney is a quarry on land of Mr. A. B. Cochran, leased by Mr. H. H. Lane, exposing the following section:

Section of "Buxton formation" 2 miles north of Caney, Kans.

	Ft.	In.
5. Weathered brown sandstone, with a few feet of rocky slope above.		
4. Massive, rather firm, slightly micaceous, light-brown sandstone, separated from No. 3 by a joint plane	5	
3. Massive, slightly friable, light-brown sandstone, with fine angular grains	5	
2. Yellowish shaly sandstone, micaceous, very fine grained	1	2
1. Massive soft sandstone, becoming harder on exposure. Angular quartz, with some chert grains and bands of iron rust	3	6

A drill is said to have shown sandstone to a depth of 8 feet below the base of the exposure. This would indicate a total thickness of over 20 feet. In natural outcrops the rock is usually stained dark brown, and at this quarry a comparatively fresh exposure showed considerable discoloration, indicating that the material is deeply oxidized. Analysis No 5 (p. 628) shows this sand to be fairly high in silica, but to contain too much iron to make anything but the commonest jar and bottle glass, and the same may be said of sand from a point on the ridge west of Havana, near the county line (No. 6, p. 627). These sands are also slightly finer than is desirable, but this may be offset by the fact that the grains are mostly sharp. Two samples from near Niotaze (Nos. 7 and 8, p. 627) proved to be altogether too fine grained and rather low in silica. The high content of alumina is due to the micaceous character of the sandstone, a feature common to the sandstones of the region. It is probable, however, that sand at present under heavier cover would prove of slightly better composition throughout this locality. This could be economically determined by shallow drilling along the sandstone ridges in the vicinity of Caney, Havana, and Niotaze, and in view of the importance of developing low-grade glass sand it might be worth while to undertake it. One drill hole in each locality, if put down in solid rock, would determine the quality of the sand much more satisfactorily than openings along the face of the bluff.

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[1] Schrader, F. C., and Haworth, E., Economic geology of the Independence quadrangle: Bull. U. S. Geol. Survey No. 296, 1906, p. 54.

Southwest of Fredonia, along the escarpment on the south side of Fall River, the sandstone is locally almost white, and such samples (Nos. 1 and 2, p. 627) on analysis proved to carry the least iron. This rock is not so friable as the St. Peter sandstone, but it can be mechanically crushed, and its evenness and comparative sharpness of grain should render it satisfactory as a low-grade glass material. The chief considerations in regard to the practicability of opening up the deposit concern the outlay for equipment and trackage, since the best material lies about 4 miles from a railroad. The large investments in glass factories in southeastern Kansas indicate faith in a long life for the industry. With permanency assured to the business, even if the cost of production here were 100 per cent greater than in districts farther east, sand might be sold at a profit and still save money to the buyer. Other outcrops, where some prospecting has been done, were found to show about 20 feet of sandstone filled with more or less ferruginous spots. The best samples that could be obtained here have been examined with results given under No. 4 (p. 627). From a bed of sandstone apparently near the base of the "Buxton formation," 1½ miles southeast of Fredonia, a sample was taken, and its properties are given under No. 3 (p. 627). Only about 6 feet of a cross-bedded sandstones show here above the level of a small creek. The rock is a light-gray micaceous, porous, soft sandstone, with grains somewhat angular and a trifle coarser than is usual in sandstones of this vicinity. The rock has a sprinkling of specks of iron rust running through it. The total thickness could not be ascertained.

The sandstone in the "Buxton formation" has been prospected with a core drill at several localities near Fredonia. A typical section revealed by this drill is as follows:

Section of drill hole in "Buxton formation" near Fredonia, Kans.

	Ft.	in.
Light-brown, slightly coarse-grained sandstone	3	1
Light yellowish-gray, medium-grained sandstone, with a few iron-oxide specks near top and bottom of bed	4	10
Brownish, medium-grained, speckled sandstone, considerably stained by iron oxide	7	2
Gray calcareous sandstone	0	6
Total	15	7

In January, 1907, a trial of this sand was made at the works of the Fredonia Window Glass Co. The sand was hauled by wagon to the works and was found to make glass of excellent quality, but for some reason it has not been developed.

Near the town of Fall River the sandstone of the "Buxton formation" is exposed at several places by the drainage system of Fall River. It is here about 20 feet thick and is parted near the middle by a thin clay seam. The upper bed of sandstone is generally iron stained, especially at the top and immediately above the clay seam. Below the clay seam is 4 to 5 feet of very clean, grayish-white, angular sandstone, rather friable. This deposit is close to the Frisco Railroad tracks. West of the town it would have to be quarried from a pit, but east of the town it rises in a bluff that stands about 30 feet above railroad level. Associated with the sandstone, but somewhat above the beds just described, is a limestone, probably the Oread or "Painterhood,"[1] which might be quarried at the same time and used for glass making. Analysis of a small sample of this rock by George Steiger, of the United States Geological Survey, is as follows:

Analysis of limestone from Fall River, Kans.

Silica (SiO_2)	2.56
Alumina (Al_2O_3)	1.55
Ferric oxide (Fe_2O_3)	.50
Ferrous oxide (FeO)	.47
Magnesia (MgO)	.06
Lime (CaO)	51.98
Water (H_2O)	1.36
Carbon dioxide (CO_2)	41.13

There is great need for a local supply of glass sand in southeastern Kansas. In the gas belt there are window-glass factories and flint or bottle and jar factories in Kansas and a factory across the line in Oklahoma. All these are obtaining sand from eastern Missouri, and in addition to the selling price of the sand the consumers are paying considerably more than that amount in freight charges. Besides the disadvantage of the high cost of sand these plants are at times subjected to a shortage of sand, due to the inability of remote producers to fill orders promptly and to the inability of railroads to move the material when it is needed.

MISSOURI.

Southeast of Crystal City there is a good development of St. Peter sandstone, in Ste. Genevieve County, and at Jackson, Cape Girardeau County, the sand has been quarried. Samples from Jackson submitted to the office of the Survey are rather fine grained and friable and contain a small proportion of sharp or subangular grains. Some of the material is iron stained, and these portions are rather firmly cemented. (See item No. 12 in tables on pp. 627–628 for properties.) Chemically this sand is well qualified for glass making, and although the sample submitted comes near the limit of fineness, screening would doubtless render it highly satisfactory.

In southwestern Missouri, near Butterfield, Barry County, on the main line of the Frisco Railroad, is a deposit of sandstone, reported to be more than 36 feet deep, outcropping at the surface or lying below a few feet of soil. Three or four cars of sand have been shipped from this place.

Just south and east of the town of Versailles lies a belt of saccharoidal sandstone, which is exposed at the top of the escarpment overlooking the ravines at the headwaters of Little Gravois Creek. This sandstone is almost everywhere capped by iron-stained quartzite, in some places cherty. The rock strikes northeast-southwest and has a low dip to the southeast. It is overlain in places by cherty beds and a very fine-grained sandstone or "cotton rock." The sandstone is regarded as the equivalent of the Roubidoux formation, of Ordovician and Cambrian age, although some of the beds may be sandstone of Carboniferous age that has been deposited in connection with the thick masses of cannel coal that are found here in pockets or sink holes. The apparent thickness of the sandstone reaches 25 feet in places, although the actual thickness may be less than this, since the exposures are principally on hillsides that slope in the direction of the dip. Below the cap of quartzite the sand is white and friable, except near joint planes, where it is somewhat iron stained and harder. The sand is white to yellowish, water-worn, and partly subangular; 100 per cent of the grains pass a 20-mesh sieve, 23 per cent pass a 40-mesh, 23 per cent pass 60-mesh, and 11 per cent pass 80-mesh. Therefore the sand, although uneven, is mostly of medium gain. The beds most suitably located for working are in the S. ½ sec. 32, T. 43 N., R. 17 W., where the rock outcrops within one-fourth mile of the Chicago, Rock Island & Pacific Railway.

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[1] Schrader, F. C., and Haworth, E., Geology of the Independence quadrangle, Kansas: Bull. U. S. Geol. Survey No. 296, 1907.

NEBRASKA.[1]

The most accessible and prominent exposures of Dakota sandstone in this State are near Ponca, Jackson, Homer, Tekamah, Ashland (at mouth of Salt Creek), Lincoln, and Beatrice, and in the southern part of Jefferson County. The sand is variably indurated. At places it contains siliceous cement and is a quartzite. There is much less calcium carbonate in the stone than is usually supposed. It may be said that ferric oxide is the prevailing matrix. Generally the sandstone is friable and easily crushed. It is thin bedded where interstratified with shales or clay and mostly massive in the upper and lower parts of the formation. At some places massive ledges grade laterally into arenaceous clays within a short distance. The color ranges from gray to the yellows and browns, varying with the amount of iron stain present. The iron oxide covers or coats the grains, but rarely occurs as an impurity in the quartz. The sands may be freed of iron by washing. The chemical analysis of a badly stained sample taken at Robbers' Cave, near Lincoln shows that the sand, if washed, might be used for green or dark glass.

When sieved, most of this sand was caught on meshes 30, 40, and 50, so that it is of remarkably even grain. It is composed largely of quartz, except when clay and mica are found. These are present where the sand rock grades horizontally into clay. In general the friable sand rock is clean, except for the iron.

OHIO.

Sandstones as yet undeveloped, but known to be suitable for glass making and for other purposes for which a high-grade sand is in demand, occur in Holmes, Jackson, Knox, Licking, and Muskingum counties, in the lower part of the Pennsylvanian, and particularly in the Sharon conglomerate member of the Pottsville formation.

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[1] Communicated by Dr. Geo. E. Condra, Dept. of Geology, Univ. of Nebraska, Lincoln, Nebr.

WISCONSIN.

In southwestern Wisconsin, along Mississippi River and its tributaries, from about Potosi nearly to Wisconsin River, the St. Peter sandstone is a persistent formation lying low in the valleys in the southwestern part of the area and rising to the tops of the hills toward the northeast. Where low in the section the sandstone is heavily covered by limestone and dolomite and in places is badly iron-stained, but in general it is protected from waters descending from the overlying formations by a bed of clay shale. The sandstone is usually so soft as to be worked with a pick and shovel, and it is quarried extensively for local uses, although it is by no means as sharp a sand as might be desired for building. It would probably make a good glass sand, but in localities along Mississippi River near the Chicago, Burlington & Quincy Railroad, where, situated close to transportation facilities, it is doubtful if it could be exploited except by mining. The distribution of the St. Peter sandstone was mapped during the survey of the Lancaster and Mineral Point quadrangles, and the maps are available in the Lancaster-Mineral Point folio (No. 145). Additional topographic maps that comprise outlying edges of this district are those of the Elkader, Waukon, and Richland Center quadrangles. Tests made of St. Peter sandstone from a point near Grant River south of Flora, Wis., indicate that its quality is all that could be desired as a glass material. (See No. 10, pp. 627–628.)

In the valley of Wisconsin River the Cambrian ("Potsdam") sandstone contains several valuable beds of clean quartz sand, rather coarse, well rounded, and loosely cemented. Exposures, probably of the Jordan sandstone, occur in the bluffs near Boscobel, Wis., in close proximity to the Chicago, Milwaukee & St. Paul Railway. The properties of sand from this locality are given under No. 11 (pp. 627–628). The chemical composition is excellent and the sand is of very desirable size.

ANALYSES OF GLASS SAND.

The following analyses submitted by the American Window Glass Co. show the different qualities of sand used eight or nine years ago in its glass works:

Analyses of glass sand used by American Window Glass Co.

Constituent.	No. 1.	No. 2.	No. 3.	No. 4.
Silica (SiO_2)	99.990	99.714	99.659	99.579
Alumina (Al_2O_3)	.008	.280	.310	.350
Iron oxide (Fe_2O_3)	Slight trace.	.006	.011	.021
Lime and magnesia (CaO and MgO)	.002	.020	.020	.050
	100.000	100.020	100.000	100.000

No. 1 is suitable for the very highest grades of glassware and flint glass. Nos. 2 and 3 are suitable for table ware, plate glass, chimneys, prescription ware, etc., and No. 4 is used for window glass. It is difficult, however, to maintain as high grades as these in average shipments.

The following analyses are submitted by the Pittsburg Plate Glass Co. as samples of sand at one time used by its plants:

Analyses of glass sand used by Pittsburg Plate Glass Co.

Constituent.	No. 1.	No. 2.	No. 3.	No. 4.
Silica (SiO_2)	99.21	98.90	98.95	98.94
Alumina (Al_2O_3)	.30	.20	.50	.30
Volatile matter	.21	.25	.24	.23
Iron oxide (Fe_2O_3)	.003	.002	.0024	.0036
Lime (CaO)	.20	.54	.30	.40
Magnesia (MgO)	Trace.	.20	.10	Trace.
	99.923	100.092	100.0924	99.8736

For sands with analyses comparable with the above, no decolorization is attempted in manufacturing plate glass. Sand containing more iron than is shown in the tables may be used in making green glass bottles and cheap glassware, or, with the addition of decolorizing agents, in making window glass.

The following analyses are fairly representative of the sands from the quarries listed below. Some were probably made on selected samples and are purer than would be shown if averaged from carload lots:

Analyses of glass sands quarried in the Central States.

Location of mine or quarry.	Operator.	Sample.	Constituent.							Authority.
			Silica (SiO_2).	Magnesia (MgO).	Lime (CaO).	Iron oxide (Fe_2O_3).	Alumina (Al_2O_3).	Other items.	Total.	
ILLINOIS.										
Ottawa, Lasalle County	Ottawa Silica Co		99.45	Trace.	0.13	0.30			99.88	Prof. R. E. Lyons, Indiana University, Bloomington, Ind.
South Ottawa, Lasalle County.	United States Silica Co		99.89	0.01	.00	Trace.	0.051		99.951	R. W. Hunt & Co., Chicago, Ill.
Wedron, Lasalle County	Wedron White Sand Co		99.89	.01	.00		.051		99.951	Cary & Moore, Chicago, Ill.
Utica, Lasalle County	E. J. Reynolds & Co		99.576	.002	.0197	.0903	.283		99.971	Operators of quarry.
MISSOURI.										
Klondike, St. Charles County.	Tavern Rock Sand Co		99.97				.03		100.00	Regis Chauvenet & Bro., St. Louis, Mo
Grays Summit, Franklin County.	White Sand Co. of Missouri		99.839			.0014		(H_2O), 0.154	99.9944	John F. Wixford, St. Louis, Mo.
Jefferson County, near Pacific.	Missouri Silica Co		99.69	.31					100.00	Regis Chauvenet & Bro., St. Louis, Mo.
INDIANA.										
Coxville	Acme Glass Sand Co., Terre Haute, Ind.		98.61	Trace.	.12	.22	.74	Loss on ignition, 0.32.	100.01	W. A. Noyes, Rose Polytechnic Institute, Terre Haute, Ind.
Loogootee	Loogootee Glass Sand Co., Loogootee, Ind.	Selected	97.78		.06	.10	1.13		99.07	J. F. Elsom, New Albany, Ind.
Do	do	Crude	96.26	.16		.92	2.50	Na_2O and K_2O, 0.13.	99.97	Operator; report of State geologist.
KENTUCKY.										
Tip Top	Kentucky Silica Co., Louisville, Ky.	Selected, washed	99.14	.08	.21	.02	.23	CO_2+H_2O, 0.52	100.20	R. B. Hulme, Louisville, Ky.
	Do	Selected	98.87	.12	.24	.08	.21	0 48	100.00	Operators of quarry.
	Do	Crude	98.404	.372	.043	.751		H_2O, 0.271	99.841	Do.

OHIO.										
Sylvania	Toledo Stone & Glass Sand Co.		98.53		.67	.007	.18		99.387	Operators of quarry.
Chalfants	National Sand Co. (in 1902)		98.506	.014		.09		H$_2$O, 0.60	99.210	Prof. Horton, Columbus, Ohio.
Massillon	Everhard Co., Massillon	Prepared for glass	97.50	.50		.50	1.50		100.00	Operators of quarry.
Do	Massillon Sand & Stone Co., Massillon.	do	98.611	Trace.	.130	.033	.123		98.897	Otto Wuth, Pittsburgh, Pa.
Do	Sonnhalter Sand & Stone Co., Massillon.	do	99.60		.23	.02		Clay (?) 0.15	100.00	Jno. McNamee, Anderson, Ind.
Dundee	F. W. Meyers, Massillon, Ohio.		98.45			.14	.77		99.36	F. A. Emmerton, Cleveland, Ohio.
Layland	Layland Stone & Sand Co. (in 1903).		98.78	.04	.12	Trace.	.73	Organic, 0.33	100.00	F. S. Schwab, Chicago, Ill.
Niles	National Sand & Stone Co	First grade, washed.	99.915	Trace.	.021	.0019	.062		99.9999	Otto Wuth, Pittsburgh, Pa.
		First grade, not washed.	98.09	.16	None.	.03	.75	Loss on ignition, 0.33.	99.36	Pittsburg Testing Laboratory, Pittsburgh, Pa.
		Second grade, not washed.	97.10	Trace.	.10	.14	2.35	H$_2$O, 0.31	100.00	Do.

In the course of the Survey's investigation of glass sand a study was made by the writer of a few of the physical properties of certain well-known sands in successful use for glass making. The data noted, which are chiefly of value for comparison when it is desired to test an unused sand, are tabulated below:

Physical properties of glass sands from Illinois, Missouri, and West Virginia.

Locality.	Operator.	Sample.	Color.	Angularity.	Sieve tests (percentages are approximate).				
					Larger than 20 mesh.	Passes 20 mesh.	Passes 40 mesh.	Passes 60 mesh.	Passes 100 mesh.
Ottawa, Ill.	Ottawa Silica Co.	Finest grained	Very faint yellow	Very little		100	100	92	25
Do	do.	Fine and coarse mixed	White	do.	A few grains	99+	85	18	3
Do	do.	Coarsest grained	do.	None	1 per cent	99	6	1−	0
Do	do.	Crude, direct from pit	Grayish white	do.	A few grains	99+	23	3	1−
Utica, Ill.	E. J. Reynolds & Co.	Crude, from car	Grayish yellow	Very little	do.	99+	45	11	3
Klondike, Mo.	Tavern Rock Sand Co.	Extra quality	White	do.	Small lumps only	100	90	15	1
Do	do.	Average quality	Faint pinkish yellow	do.	Fine lumps only	100	82	17	2
Do	do.	Crude, direct from pit	White	None		100	90	15	1
Grays Summit, Mo.	White Sand Co. of Missouri.	Finished product	do.	Very little		100	92	25	2
Do	do.	Crude, from quarry	Very light gray	do.	Fine lumps only	100	88	55	1−
Pacific, Mo.	Pacific White Sand Co.	Finished product	Faint pinkish white	None	Small lumps only	100	85	12	2
Do	Missouri Silica Co.	Direct from quarry	Faint yellow	do.	do.	100	96	42	2
Do	Pacific Glass Sand Co.	Prepared for plate glass	Faint yellowish white.	A little of finest grain		100	99	60	10
Do	do.	Dried, not screened	Faint yellow	None	Small lumps	100	90	22	2
Do	do.	Crude, mine run	do.	Very little	do.	100	85	65	5
Crystal City, Mo.	Pittsburg Plate Glass Co.	Prepared	do.	do.	Less than 1 per cent	99+	23	13	1
Do	do.	Average mine run	White, with faint yellow lumps.	None		100	55	20	1
Berkeley Springs, W. Va.	West Virginia Sand Co.	Crushed sandstone, finished product.	Grayish white	90 per cent		100	98	25	1−

The following chemical analyses made by Mr. Steiger and the subjoined physical analyses made by the writer indicate the character of a few of the promising undeveloped materials:

Partial analyses of sands from Arkansas, Kansas, Missouri, and Wisconsin of possible value for making glass.

[Analyst, George Steiger, United States Geological Survey.]

No.	Location of outcrop or quarry.	Owner.	Constituent.					
			Silica (SiO_2).	Magnesia (MgO).	Lime (CaO).	Oxide of iron (Fe_2O_3).	Alumina (Al_2O_3).	Total.
	KANSAS.		*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
1	Sec. 20, T. 29 S., R. 14 E., Wilson County	Mrs. Hall, Fredonia, Kans	97.59			0.33		97.92
2	Secs. 20 and 21, T. 29 S., R. 14 E., Wilson County	C. D. Roberts, Fredonia, Kans	98.00			.37		98.37
3	1½ miles southeast of Fredonia	F. Butts, Fredonia, Kans	97.50		0.10	.43	1.62	99.65
4	5 miles southwest of Fredonia	Orval Jeffers, Fredonia, Kans	97.94			.63		98.57
5	Sec. 36, T. 34 S., R. 13 E., Montgomery County	A. B. Cochran, Caney, Kans	97.08			.72		97.80
6	Sec. 13, T. 34 S., R. 13 E., Havana, Montgomery County		97.80			.84		98.64
7	S. ½ SE. ¼ sec. 19, T. 34 S., R. 13 E., Niotaze, Chautauqua County	George Tame, Niotaze, Kans	96.45			.37	2.76	99.58
8	do	do	96.90			.67	2.93	99.60
	ARKANSAS.							
9	Sec. 4, T. 17 N., R. 18 W., Everton, Boone County		99.55			.09	.13	99.77
	WISCONSIN.							
10	Sec. 22, T. 4 N., R. 4 W., Flora, Grant County		99.17			.22	.25	99.64
11	2½ miles southeast of Boscobel, Grant County		99.47			.07		99.54
	MISSOURI.							
12	Jackson, Cape Girardeau County	Jackson Lime and Quarry Co	99.52			.07	.16	99.75

Physical properties of sands of possible value for making glass.

No.	Locality.[a]	Color.	Angularity.	Sieve tests. (Percentages are approximate.)				
				Larger than 20 mesh.	Passes 20 mesh.	Passes 40 mesh.	Passes 60 mesh.	Passes 100 mesh.
					Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
1	Fredonia, Kans	Grayish white	80 per cent	Small lumps	100	99	60	15
2	.....do	.....do	.....do	.....do	100	100	65	20
3	.....do	Light grayish brown	90 per cent	.....do	100	85	35	10
4	.....do	Yellowish brown	.....do	.....do	100	80	60	15
5	Caney, Kans	Light yellowish brown	Mostly sharp		100	100	95	35
6	Havana, Kans	Pinkish brown	.....do	Few small lumps	100	100	80	20
7	Niotaze, Kans	White	.....do	Few lumps	100	100	100	90
8	.....do	Light yellowish brown	.....do	.....do	100	100	90	50
9	Everton, Ark	Grayish white	About 30 per cent	A few grains	99+	97	50	10
10	Flora, Wis	.....do	None	.....do	99+	80	40	15
11	Boscobel, Wis	Pale green and white	Very little	1+ per cent	98+	35	6	1−
12	Jackson, Mo	Faint pinkish white	.....do	Fine lumps	100	99	80	10

[a] See preceding table for township, section, etc.

Below are given a number of analyses of high-grade silica sands not mentioned above. Many of these sands are in use for making glass and for other purposes; others are undeveloped.

Analyses of sands, high in silica, quarried in various parts of the United States.

Location of deposit.	Owner.	Authority.	Silica (SiO_2).	Alumina (Al_2O_3).	Ferric oxide (Fe_2O_3).	Calcium oxide (lime) (CaO).	Magnesium oxide (MgO).	Loss by ignition (mostly water and organic matter).	Other minerals.	Total.	Remarks.
ALABAMA:											
Jefferson County—											
Gate City		Robert S. Hodges, University of Alabama.	*Per ct.* 98.80	*Per ct.* 0.75	*Per ct.* 0.31	*Per ct.* 0.05	*Per ct.* 0.10	*Per ct.*	Titanium oxide (TiO_2), 0.10 per cent.	*Per ct.* 100.11	Sand; deposit undeveloped.
Do		do	97.22	1.88	.24	.06	.09		Titanium oxide (TiO_2), 0.21 per cent.	99.70	Sandstone; deposit undeveloped.
Irondale		do	97.93	1.05	.19	.06	.33	0.51	Titanium oxide (TiO_2), 0.12 per cent.	100.19	Glass sand; deposit undeveloped.
North Birmingham.		do	97.30	1.39	.33	.07	.18	.57	Titanium oxide (TiO_2), 0.16 per cent.	100.00	Sandstone; undeveloped.
Trussville	Dr. S. W. Acton	Chemist, Southern Steel Co.	98.00							98.00	White sand.
Do	Trussville Sand Co.	do	98.00							98.00	
Do		do	98.05	.22	.20	Trace.	.78			99.25	Glass sand; deposit undeveloped.
Trussville (1 m. north of Acton quarry).		Robert S. Hodges, University of Alabama.	98.30	.98	.19	.09	.02	.40	Titanium oxide (TiO_2), 0.09 per cent.	100.07	Glass sand; deposit undeveloped.
ARKANSAS:											
Izard County—											
Guion		Roy V. Pepperberg, University of Nebraska.	99.52	Trace.	.0543	Trace.	Trace.	.0157		99.59	Do.
Do	Arkansas Silica Sand Co., Carthage, Mo.	W. George Waring, Webb City, Mo.	99.70	.11				.17	Calcium carbonate ($CaCO_3$), 0.02 per cent.	100.00	Do.
CALIFORNIA:											
Los Angeles County—											
Lancaster	Quartz Glass and Mfg. Co., Los Angeles.		98.80		Trace.	Trace.				98.80	Glass sand and building sand.
Yuba County—											
Marysville	C. F. Aaron	Continuous Glass Press Co., Philadelphia, Pa.	97.13	1.55	.61	.37		.34	Trace of gold	100.00	

Analyses of sands, high in silica, quarried in various parts of the United States—Continued.

Location of deposit.	Owner.	Authority.	Silica (SiO_2).	Alumina (Al_2O_3).	Ferric oxide (Fe_2O_3).	Calcium oxide (lime) (CaO).	Magnesium oxide (MgO).	Loss by ignition (mostly water and organic matter).	Other minerals.	Total.	Remarks.
FLORIDA:											
Hillsboro County—Tarpon Springs.	Triton Silica Mining & Mfg. Co.	Ledoux & Co., New York.	*Per ct.* 99.34	*Per ct.* 0.297	*Per ct.* a 0.058	*Per ct.* 0.014	*Per ct.* 0.010	*Per ct.*	Water and ignition loss, 0.13 per cent.	*Per ct.*	Glass sand.
Escambia County—Pensacola		George Steiger, U. S. Geological Survey.	99.65			None.				99.65	Sea sand.
Marion County—Sandy Hook (near Lake Weir).	Lake Weir Sand and Stone Co.	R. E. Rose, Tallahassee, Fla.	99.90		Trace.		None.	.10		100.00	
GEORGIA:											
Walker County—Near Chattanooga, Tenn.	A. W. Morse, Alton Park, Tenn.		98.37		1.72	Trace.				100.09	Molding sand.
ILLINOIS:											
Lasalle County—Ottawa	H. W. Bellrose Sand Co., Wedron.		98.00							98.00	White sand, crude; molding and grinding.
Do	do		99.90							99.90	Washed and dried; molding and grinding.
Do	Ottawa Silica Co	R. E. Lyons, University of Indiana.	99.82	.05		.13				100.00	Glass sand, molding sand.
Madison County—Alton	H. J. Bowman	Laboratory, Washington University, St. Louis, Mo.	99.87			.13				100.00	
Do	do	R. W. Hunt & Co., Chicago, Ill.	98.82		1.03					99.85	
INDIANA:											
Fountain County—Attica	Western Silica Co., Danville, Ill.	State geologist of Indiana.	98.84	.38	.10		.03	.32	Titanium oxide, (TiO_2), trace.	99.67	
IOWA:											
Clayton County—Clayton	Clayton White Sand Co.		98.850	.480	FeO .095	.210	None.	.114	Potassium and sodium oxides (K_2O and Na_2O), 0.027 per cent.	100.019	Furnace sand.

Woodbury County—SiouxCity(near Springdale station).		George Steiger, U. S. Geological Survey.	96.90	1.22	+FeO .28	.14	.05	1.07		99.66	Soft, friable sandstone.
KANSAS:											
Greenwood County—											
Fall River, ¼ m. E. R. R. station.		do	97.28	.96	+FeO .80	.13	.04	.73		99.94	Friable sandstone.
SE. ¼ sec. 13, T. 28 S., R. 12 E., No. 1.		do	98.24	.57	+FeO .35	.06	.04	.72		99.98	Friable sandstone undeveloped. Selected from different beds of same vertical section. Possibly glass sand.
SE. ¼ sec. 13, T. 28 S., R. 12 E., No. 2.		do	97.81	.73	+FeO .35	.18	.05	.80		99.92	
SE. ¼ sec. 13, T. 28 S., R. 12 E., No. 3.		do	98.02	.81	+FeO .26	.08	.06	.81		100.04	
Neodesha	Doolittle Place	do	98.71		.19					98.90	
Wilson County—New Albany	Empire Brick and Gas Co.	W. W. Petraeus, Joplin, Mo.	98.20		1.65					99.85	
KENTUCKY:											
Carter County—Olive Hill	Lawton Sand and Supply Co.	Laboratory, Agricultural Experiment Station, Lexington.	99.10	.39	.13	.03	Trace.	.22	Titanium oxide (TiO_2), trace.	99.87	Glass sand.
MARYLAND:											
Allegany County—Cumberland	Cumberland Sand Co.	Maryland Geological Survey.	99.55	.30	None.	Trace.	None.	.10		99.95	Building sand; filtration sand.
Anne Arundel County—Robinson	Brennan Sand Co., Philadelphia, Pa.	J. G. Vail	99.50		.20				Clay, 0.30 per cent	100.00	Glass sand.
Do	do	A. E. Elkinton, Philadelphia, Pa.	98.80	1.00	.10		.10			100.00	Do.
MASSACHUSETTS:											
Berkshire County—Cheshire	Berkshire Glass Sand Co.	Worcester Polytechnic Institute, Worcester.	99.31	.58		.11				100.00	Do.
Do	do	do	99.46	.48		.06				100.00	Do.
Do	do	State Assay Laboratory, Boston.	99.78	[b].22		(c)				100.00	Do.
MICHIGAN:											
Wayne County—Rockwood	American Silica Co.	John E. Clark, Detroit.	99.70						Calcium carbonate ($CaCO_3$), 0.08 per cent. Magnesium carbonate ($MgCO_3$), 0.22 per cent.	100.00	Do.

[a] Ferrous oxide (FeO).

[b] Includes calcium oxide, CaO.

[c] Included with alumina.

Analyses of sands, high in silica, quarried in various parts of the United States—Continued.

Location of deposit.	Owner.	Authority.	Silica (SiO_2).	Alumina (Al_2O_3).	Ferric oxide (Fe_2O_3).	Calcium oxide (lime) (CaO).	Magnesium oxide (MgO).	Loss by ignition (mostly water and organic matter).	Other minerals.	Total.	Remarks.
MISSOURI:											
			Per ct.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*		*Per ct.*	
Cape Girardeau County—Jackson	Jackson Lime & Quarry Co.	George Steiger, U. S. Geological Survey.	99.52	0.16	0.07					99.75	Glass sand.
Morgan County—Versailles		do	99.03	.40	FeO.13	0.29	0.11	0.44		100.40	Glass sand; undeveloped property.
St. Louis County—Near Pacific	Pacific Glass Sand Co.	Laboratory, St. Louis Plate Glass Co., St. Louis.	99.20	.56		Trace.	.20	.08		100.04	Glass sand.
NEW JERSEY:											
Camden County—Berlin (Tansboro).	S. W. Downer	T. A. Genth, Philadelphia, Pa.	99.65	.05	.08	.15	.01	.07		100.01	Glass sand; fire sand.
Gloucester County—Downer	do	New Jersey Geological Survey.	99.52	.1856	.0096	.006	.007	.19	Titanium oxide (TiO_2), 0.0868 per cent.	100.005	
Williamstown	Weirich & Field, Philadelphia, Pa.	George E. Davis, Philadelphia, Pa.	98.89		.13					99.02	Glass sand.
Middlesex County—Jamesburg	Brookfield Glass Co., New York, N. Y.	Lederle Laboratories, New York, N. Y.	97.46	1.56	.26	.40		.32		100.00	Do.
Sayreville	Crossman & Co., South Amboy.		98.00							98.00	Molding sand; fire sand.
OHIO:											
Tuscarawas County—Dundee	Dundee Silica Sand Co.	F. A. Emmerton, Cleveland.	99.60							99.60	No. 1 sand; glass sand.
Do	do	do	98.87							98.87	No. 2 sand.
Do	do	do	98.63							98.63	No. 3 sand.
Do	F. W. Meyer	do	98.45	.77	.14					99.36	
Do	Beach City Silica Sand Co.	do	98.43		.25	None.	.08		Manganese oxide (MnO); phosphorus (P); sulphur (S), none.	98.76	

PENNSYLVANIA:											
Chester County—											
Exton	Whiteland Silica Co., Lockport, N. Y.	H. C. Harrison	98.98							98.98	
Clarion County—											
Foxburg	Foxburg Sand & Stone Co., Pittsburgh.	Gulick & Henderson, Pittsburgh.	98.06	.32	.74	.06	.02			99.20	Glass sand.
Elk County—											
Ridgway	The Fox Sand Co		98.69							98.69	Glass sand.
Do	Ridgway Sandstone Co.	International Text Book Co., Pittsburgh.	98.55	1.22	.21	Trace.	Trace.			99.98	Glass sand, molding sand, etc.
Huntingdon County—											
Mapleton Depot	Juniata White Sand Co.	Otto Wuth, Pittsburgh	99.85	.14	.012	Trace.				100.02	Glass sand.
Do	Pennsylvania Glass Sand Co.	Booth, Garrett & Blair, Philadelphia.	99.70	.24	.026	Trace.	Trace.			99.966	Do.
Do	Pittsburg White Sand Co., Lewistown.	Laboratory, Pennsylvania State College, Philadelphia.	99.65	.09		.26				100.00	Do.
Markleysburg (near Aitch).	Standard Sand Co., Altoona.	C. B. Dudley, Chemist P. R. R. Co.	98.70	.81		Trace.	None.	0.49		100.00	Do.
Mill Creek	Pennsylvania Glass Sand Co., Lewistown.	Booth, Garrett & Blair, Philadelphia.	99.72	.25	.014	Trace.	Trace.			99.984	Do.
Do	do	do	99.83	.12	.01	.04				100.00	Do.
Do	Westbrook Sand Glass Co., Tyrone.	M. L. Cressman, Lewistown.	99.00	.20	Trace.	.40	.40			100.00	Do.
Jefferson County—											
Near Falls Creek, Clearfield Co.	Crystal Window Glass Co.	Otto Wuth, Pittsburgh	99.410	.551	.029	.101	Trace.			100.091	Do.
McKean County—											
Sergeant Station (near Burrows).	Sergeant Glass Co., Burrows.	Wm. L. Heim	98.42	.80	.27	.14	.12	.25		100.00	Washed glass sand.
Mercer County—											
Greenville	Greenville Silica Sand and Quarry Co.	Otto Wuth, Pittsburgh	99.822	.156	.02	.0036				100.0016	Sand from rock, average of ten samples.
Venango County—											
Kennerdell	Kennerdell Sand and Manufacturing Co., Pittsburgh.	G. P. Maury, The Metallurgical Laboratory, Pittsburgh.	99.25	.60		Trace.	Trace.	.20		100.05	Glass sand.
Warren County—											
Torpedo	The White Silica Sand and Cement Brick Co., Erie.	Erie Laboratory, Erie.	98.69	.64	.34	.06	Trace.	.25		99.98	Yellow sample unwashed and unscreened.
Do	do	do	99.02	.58	.14	Trace.	Trace.	.23		99.97	White sample, unwashed and unscreened.

Analyses of sands, high in silica, quarried in various parts of the United States—Continued.

Location of deposit.	Owner.	Authority.	Silica (SiO_2).	Alumina (Al_2O_3).	Ferric oxide (Fe_2O_3).	Calcium oxide (lime) (CaO).	Magnesium oxide (MgO).	Loss by ignition (mostly water and organic matter).	Other minerals.	Total.	Remarks.
Westmoreland County—			*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*		*Per ct.*	
Derry	American Window Glass Co., Pittsburgh.	Engineers and Founders Laboratory, Pittsburgh.	99.25	0.25	0.06	0.05		0.38		99.99	Glass sand, washed.
Do	do	Otto Wuth, Pittsburgh	98.76	.932	.054	.183	0.071			100.00	Glass sand.
Do	Derry Glass Sand Co., Latrobe.	E. S. Brown, Latrobe.	99.65	.17	.11	.02	.03			99.98	Do.
Seward (near)		A. J. Phillips	97.54	.81	.09	1.04	.06	.52	Sodium oxide (Na_2O), 0.02; Potassium oxide (K_2O), 0.16; Sulphuric anhydride (SO_3), trace.	100.24	Glass sand from Pottsville formation.
TENNESSEE:											
Hardeman County – Saulsbury	Durden Sand Co	Foster Laboratory, Sheffield, Ala.	92.70	.26	3.30	Trace.		.15		96.41	Glass sand.
Do	do	do	94.90	.17	2.40	Trace.		.25		97.72	Do.
Do	do	do	91.00	.23	3.50	Trace.		.75		95.48	
UTAH:											
Salt Lake County—Near Salt Lake City.	Crystal Lime and Cement Co.	F. M. Bishop	99.00	.10	Trace.				Calcium carbonate ($CaCO_3$), 0.40 per cent.	99.50	
VIRGINIA:											
Roanoke County—Salem	Catawba Valley Railway Mining Co.	C. N. Sanders	99.04	.28	.70					99.74	Do.
Do	Cooper Glass and Silica Co.	W. L. Watts, West End Furnace, Roanoke.	98.80	.28	.11	Trace.	Trace.	.60	Trace of alkalies	99.79	Do.
Do	do	Froehling & Robertson, Richmond.	97.18	1.38	.28	.18	.11	.44	Potassium oxide (K_2O), 0.21; sodium oxide (Na_2O), 0.20 per cent.	99.98	Do.

WEST VIRGINIA:											
Hampshire County—Green Spring...	Potomac White Sand Co., Cumberland, Md.	F. T. Ashman Co., Pittsburgh, Pa.	99.19	....	.56	....	....	....	....	99.75	Do.
Monongalia County—Sturgisson......	Decker Creek Stone and Sand Co.	Laboratory, West Virginia Experiment Station.	99.55	....	.33	....	....	.11	....	99.99	Glass sand.
Star City.......	R. B. Reid...........	C. S. Howard, University of West Virginia.	99.04	.60	.12	Trace.	.04	.20	....	100.00	Dried at 110°, white sample.
Do.........	.....do................	.....do................	98.40	.54	.41	.04	.21	.40	....	100.00	Dried at 110°, reddish sample.
Morgan County—Berkeley Springs.	Berkeley Sand Co.....	Pittsburg Testing Laboratory, Pittsburgh, Pa.	99.37	.33	.04	....	....	.17	Cobalt (Co), none.......	99.91	Glass sand.
Do.........	Speer White Sand Co.	Otto Wuth, Pittsburgh, Pa.	99.701	.291	.008	Trace.	Trace.	....	....	100.00	Do.
Do.........	West Virginia and Pittsburg Sand Co.	....	99.89	.105	.005	Trace.	....	....	....	100.00	Do.
(Near) Hancock, Md.	Pennsylvania Glass Sand Co., Lewistown, Pa.	Otto Wuth, Pittsburgh, Pa.	99.889	.094	.006	.011	....	....	....	100.00	Do.
Preston County—Corinth........	Corinthian White Sand Co.	....	99.936	.043	FeO.021	Trace.	Trace.	....	....	100.00	Do.
Independence..	Irvington Mineral Co..	National Canners Laboratory, Aspinwall, Pa.	99.73	....	.06	....	....	....	....	99.79	Do.
Randolph County—Silica...........	Enterprise Silica Sand Co., Bellaire, Ohio.	Wheeling Steel and Iron Works, Wheeling.	98.75	....	....	....	....	....	....	98.75	Do.
Do.........	.....do................	.....do................	99.12	.28	.33	....	....	.27	....	100.00	
Upshur County—Craddock.......	Silica Sand Co........	Laboratory, National Tube Co.	99.38	.38	.13	.005	Trace.	....	....	99.895	
Do.........	.....do................	Laboratory, Carnegie Steel Co.	99.46	.15	.25	.14	....	....	....	100.00	
Do.........	.....do................	.....do................	99.38	....	.26	.36	....	....	....	100.00	
WISCONSIN:											
Columbia County—Portage........	Columbia Silica Co....	A. S. Mitchell, Milwaukee.	99.20	.57	.02	.21		....	....	100.00	Do.

GENERAL ASPECTS OF GLASS-SAND INDUSTRY.

The consumption of glass sand has been rapidly increasing for many years, and it is probable that it will continue to increase indefinitely. Vast resources of the material are in sight. The uses for glass are now so varied and extensive that it may well be classed with iron and cement in its importance as a structural material. Glass sand in situ possesses relatively little intrinsic value. The market value is due to the labor cost of extraction and preparation.

The factors on which a deposit of sand depends for its possible value for making glass are (1) chemical purity, (2) physical character, (3) quantity available, (4) location with respect to fuel supplies, (5) conditions of quarrying or mining, (6) location with respect to transportation routes, and (7) location with respect to markets. The first two have been treated rather fully in the foregoing pages.

A deposit so thin as 20 feet should have an areal extent of at least 20 acres of good sand in sight to warrant the erection of a mill and trackage. Most deposits are thicker than 20 feet, but it would be safer to have a much higher ratio between areal extent and thickness than the minimum given. Where ledges of sand require stripping of overlying limestone, the limestone may in certain cases be of such purity that it also could be used for glass making. If this is not the case, other uses should be sought for it as a by-product. In regard to fuel, every plant turning out glass sand in quantity sufficient to net a profit must be equipped with power for moving the sand and drying it, and in most cases with equipment for cleaning it as well. The margin of profit is at present so low that the cost of preparation can not reasonably stand freight charges on coal for more than 50 miles. Natural gas would be a suitable fuel, especially in the operation of rotary driers. In respect to transportation routes, the general principle "the more available the better" is applicable. Aside from the necessity of securing fair and uniform freight rates experience has shown, especially where the dependence is on only one railroad for transportation, that shortness of cars at certain seasons may seriously handicap a plant in its shipments and lead to cancellation of many orders. In respect to markets, it must be considered that sand is for its value one of the bulkiest products, and therefore one whose cost to the consumer is greatly influenced by distance. At the same time the question of permanence of these markets must be considered.

Some of the large sand properties, together with their mills, represent an outlay of $75,000 to $100,000, a sum that requires good business judgment for its investment and subsequent careful management in order to keep it paying adequate interest. Strong competition in the Middle States has forced prices down very low at present, and competition in the form of the small producer who leases a sand bank and works out by hand and team all the choice sand within convenient distance and then abandons the quarry, having figured only daily wages to himself as profit, has resulted in some embarrassment to the larger companies.

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GYPSUM.

By Ernest F. Burchard.

INTRODUCTION.

The noteworthy items with regard to the gypsum industry in 1911 as compared with 1910 are the decrease in quantity of raw gypsum mined, the decreased output of gypsum products, the decreased average price of these products, the replacement of a number of old mills by a smaller number of larger modern mills, and the trend of the industry toward the establishment, in commercial centers remote from gypsum deposits, of mixing plants or mills that assemble calcined plaster, retarder, fiber, hair, sand, etc., and turn out finished wall plasters. This latest development should result in the saving of freight charges on finished plasters and enable the products to be sold to the consumer at lower prices.

The chapter on the gypsum industry in 1910 included sections on the character of gypsum, on gypsum products, on the chemistry and practice of gypsum burning, on the distribution of gypsum deposits and plaster mills by States, with a map, and a bibliography of publications on gypsum, all of which are omitted from the present chapter because a larger edition than usual was published of the advance chapter for 1910 and copies of that issue are still available for free distribution.

PRODUCTION.

The quantity of gypsum mined in 1911 was 2,323,970 short tons, a decrease of 1.05 per cent from the production of 1910, which was 2,379,057 short tons, and an increase of 3.16 per cent over that of 1909, which was 2,252,785 short tons. The gypsum sold without calcining and used principally as land plaster and as an ingredient in Portland cement and in paint amounting to 387,480 short tons, valued at $589,479, showed a decrease in quantity of 34,349 tons and in value of $80,018, as compared with 421,829 short tons, valued at $669,497, in 1910; but the material calcined for plaster increased in quantity 14,749 short tons and in value $19,024. The total value of gypsum and gypsum products in 1911 was $6,462,035, as compared with $6,523,029 in 1910, a decrease of $60,994, or 0.94 per cent.

Gypsum was produced in 17 States and in Alaska, and the total number of mills reporting in 1911 was 78, as compared with 82 in 1910. This includes mills using domestic material that calcined wall plaster, as well as those that ground raw gypsum for land plaster and for other purposes. The largest quantity of raw gypsum produced was reported from New York. Iowa occupied second place and Michigan third. New York and Iowa both produced a larger quantity of gypsum in 1911 than in 1910, but the production in Michigan decreased slightly. The total value in New York increased slightly, but in both Iowa and Michigan it decreased. Sales of gypsum products are credited to the following States which are not producers of raw gypsum: Georgia, Illinois, Minnesota, Missouri, and Wisconsin. This is rendered necessary by the recent trend of the gypsum industry toward assembling calcined gypsum, retarder, fiber, sand, etc., and preparing plasters for the market at local mixing mills from which they may be more readily and economically distributed to the trade territory. Sales made from mixing mills and from warehouses as reported to the Survey are credited to the State in which the warehouse is located.

The raw gypsum ground and sold as land plaster amounted to 52,880 short tons, valued at $97,573, in 1911, compared with 53,815 tons, valued at $110,325, in 1910, a decrease in quantity of 935 short tons and in value of $12,752. The average price per ton at the mills received for land plaster was reported to be $1.85 in 1911, compared with $2.05 in 1910, a decrease of 20 cents a ton, or 9.76 per cent. The gypsum rock sold for the manufacture of paint, wall tints, Portland cement, and various other purposes, in the raw state, amounted to 334,600 short tons, valued at $491,906, in 1911, compared with 368,014 tons, valued at $559,172, in 1910, a decrease in quantity of 33,414 short tons and in value of $67,266. The average price of this class of products in 1911 was $1.47 per ton, compared with $1.52 in 1910, a decrease of 5 cents per ton, or 3.29 per cent. The average price of calcined gypsum products including wall plasters, plaster of Paris, Keenes cement, dental plaster, etc., was $3.67 per ton, compared with $3.70 in 1910, a decrease of 3 cents per ton, or 0.81 per cent.

The following table gives the statistical data regarding the gypsum industry in 1910 and 1911, by States:

Production of gypsum in the United States in 1910 and 1911, by States and uses, in short tons.

1910.

State.	Number of mills reporting.	Total mined.	Sold without calcining.				Sold as calcined plaster.		Total value.
			Ground for land plaster.		For Portland cement, paint, bedding plate glass, and other purposes.		Quantity.	Value.	
			Quantity.	Value.	Quantity.	Value.			
Alaska, Arizona, Montana, New Mexico, South Dakota, and Wyoming	11	211,080	280	$1,009	17,653	$38,476	121,898	$614,807	$654,292
California	7	45,901	4,960	14,185	17,318	46,090	31,824	181,928	242,203
Colorado	4	45,820	....	....	(a)	(a)	37,062	118,809	118,809
Iowa	6	322,713	6,159	8,312	30,532	38,683	230,932	896,854	943,849
Kansas	7	135,088	[b] 3,751	7,223	41,859	49,971	75,445	320,028	377,222
Michigan	8	357,174	7,097	9,900	57,469	78,478	240,905	579,823	668,201
Nevada and Oregon	5	103,329	4,410	9,322	(a)	(a)	86,123	443,596	452,918
New York	13	467,339	12,494	25,462	160,666	240,148	248,862	888,367	1,153,977
Ohio and Virginia	4	292,987	10,479	24,071	19,292	37,767	226,516	759,375	821,213
Oklahoma	10	162,788	(c)	(c)	10,924	13,896	116,968	442,191	941,256
Texas	3	188,559	(c)	(c)			135,801	485,169	
Utah	4	46,279	4,185	10,841	[d]12,301	15,663	31,333	122,585	149,089
Total	82	2,379,057	53,815	110,325	368,014	559,172	1,583,669	5,853,532	6,523,029

1911.

State.	Number of mills reporting.	Total mined.	Sold without calcining.				Sold as calcined plaster.		Total value.
			Ground for land plaster.		For Portland cement, paint, bedding plate glass, and other purposes.		Quantity.	Value.	
			Quantity.	Value.	Quantity.	Value.			
Alaska, Arizona, Georgia,[e] Illinois,[e] Minnesota,[e] Missouri,[e] Montana, New Mexico, South Dakota, Washington,[e] and Wisconsin [e]	8	129,193	382	$1,374	13,537	$43,672	151,376	$784,164	$829,210
California	6	43,855	7,399	18,280	15,726	42,193	25,144	143,791	204,264
Colorado	4	26,226	....	....	(f)	(f)	19,194	59,936	59,936
Iowa	6	354,204	(g)	(g)	(g)	(g)	229,890	857,287	857,287
Kansas	6	122,579	[h] 4,736	8,702	[i] 47,191	47,765	70,795	288,736	345,203
Michigan	8	347,296	15,548	15,706	63,502	69,549	206,299	488,671	573,926
Nevada and Utah	6	133,960	4,893	9,253	[j]15,562	23,339	98,419	413,463	446,055
New York	12	472,834	7,960	17,426	149,722	213,903	268,785	968,267	1,199,596
Ohio and Virginia	5	360,858	11,962	26,832	21,166	41,880	283,672	987,856	1,056,568
Oklahoma	10	108,653	(g)	(g)	8,194	9,605	75,081	277,986	287,591
Texas	4	179,625	(g)	(g)	(g)	(g)	139,023	486,162	486,162
Wyoming	3	44,687	....	....	....	....	30,740	116,237	116,237
Total	78	2,323,970	52,880	97,573	334,600	491,906	1,598,418	5,872,556	6,462,035

[a] Included in Utah.
[b] Includes Oklahoma and Texas.
[c] Included in Kansas.
[d] Includes Colorado, Nevada, and Oregon.
[e] Produces no crude gypsum.
[f] Included in Nevada and Utah.
[g] Included in Kansas.
[h] Includes Iowa, Texas, and Oklahoma.
[i] Includes Iowa and Texas.
[j] Includes Colorado.

Crude gypsum mined in the United States, 1880–1911.

	Short tons.		Short tons.		Short tons.
1880	90,000	1891	208,126	1902	816,478
1881	85,000	1892	256,259	1903	1,041,704
1882	100,000	1893	253,615	1904	940,917
1883	90,000	1894	239,312	1905	1,043,202
1884	90,000	1895	265,503	1906	1,540,585
1885	90,405	1896	224,254	1907	1,751,748
1886	95,250	1897	288,982	1908	1,721,829
1887	95,000	1898	291,638	1909	2,252,785
1888	110,000	1899	486,235	1910	2,379,057
1889	267,769	1900	594,462	1911	2,323,970
1890	182,995	1901	633,791		

Marketed production of gypsum in the United States, 1910–11, by uses, in short tons.

	1910			1911		
	Quantity.	Value.	Average price per ton.	Quantity.	Value.	Average price per ton.
Sold without calcining:						
For Portland cement	334,815	$522,693	$1.56	327,953	$484,373	$1.48
For paint material	1,297	2,386	1.84	(a)	(a)	....
As land plaster	53,815	110,325	2.05	52,880	97,573	1.85
For other purposes	[b] 31,902	34,093	1.07	[c] 6,647	7,533	1.13
Total	421,829	669,497	1.59	387,480	589,479	1.52
Sold calcined:						
For dental plaster	115	805	7.00	413	2,612	6.32
As plaster of Paris, wall plaster, Keenes cement, etc.	[d] 1,483,046	5,599,353	3.78	1,523,263	5,678,453	3.73
To glass factories	15,943	29,185	1.83	33,472	80,220	2.40
For Portland cement and other purposes	84,565	224,189	2.65	41,270	111,271	2.70
Total	1,583,669	5,853,532	3.70	1,598,418	5,872,556	3.67
Grand total	2,005,498	6,523,029	3.25	1,985,898	6,462,035	3.25

[a] Included in "For other purposes."

[b] Includes some plaster material.

[c] Includes some paint material.

[d] Includes some dental plaster and other gypsum products.

Marketed production of gypsum in the United States, 1907–1911, in short tons.

Year.	Sold without calcining.			Sold as calcined plaster.			Total value.
	Quantity.	Value.	Average price per ton.	Quantity.	Value.	Average price per ton.	
1907	279,397	$540,068	$1.93	1,125,301	$4,402,196	$3.91	$4,942,2
1908	246,703	425,632	1.73	1,125,617	3,650,192	3.24	4,075,8
1909	341,855	552,509	1.62	1,514,037	5,354,229	3.54	5,906,7
1910	421,829	669,497	1.59	1,583,669	5,853,532	3.70	6,523,0
1911	387,480	589,479	1.52	1,598,418	5,872,556	3.67	6,462,0

IMPORTS.

The gypsum imported into the United States comes, except a fe hundred tons annually from France and Great Britain, almos wholly from Nova Scotia and New Brunswick, and enters the port of the New England and North Atlantic States. more than half of entering the port of New York. This imported gypsum is nearly a calcined and converted into wall plasters by plants on Long Islan and in eastern New York, as well as along the seaboard as far ea as Red Beach, Me. A small quantity of the imported material used crude as land plaster, and some is mixed in patent fertilize In the statistics of gypsum products given on previous pages t product from raw material produced in the United States only considered.

A decided decrease in total value of imports occurred in 1911, co pared with the preceding year, the decrease amounting to $51,30 whereas increases of $76,974 and of $70,734 were noted in 1910 a 1909, respectively.

The following table gives such statistics concerning the impo of gypsum and gypsum products as are issued by the Bureau Statistics:

Gypsum imported and entered for consumption in the United States, 1907–1911, in short tons.

Year.	Unground.		Ground or calcined.		Value of manufactured plaster of Paris.	Total value.
	Quantity.	Value.	Quantity.	Value.		
1907	453,911	$486,205	1,979	$12,825	$36,628	$535,658
1908	300,158	314,845	1,889	12,825	26,733	354,403
1909	350,160	376,790	3,437	21,799	26,548	425,137
1910	415,321	444,263	2,414	15,072	42,776	502,111
1911	389,874	413,119	388	3,353	34,334	450,806

PRODUCTION IN OTHER COUNTRIES.

The following table gives the production of gypsum in other countries from 1906 to 1910, inclusive:

Production of gypsum in other countries, 1906–1910, in short tons.

Year.	France.		United States.		Canada.	
	Quantity.	Value.	Quantity.	Value.	Quantity.[a]	Value.
1906	1,517,603	$2,423,615	1,540,585	$3,837,975	417,755	$591,828
1907	1,559,685	2,598,828	1,751,748	4,942,264	485,921	646,914
1908	1,553,173	2,559,521	1,721,829	4,075,824	340,964	575,701
1909	1,460,271	2,426,110	2,252,785	5,906,738	473,129	809,632
1910	(b)	(b)	2,379,057	6,523,029	525,246	934,446

Year.	United Kingdom.		German Empire (Bavaria).		Algeria.		Cyprus.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.[c]	Value.
1906	252,030	$362,761	55,956	$22,011	30,809	$85,446	23,069	$55,658
1907	263,779	431,313	53,985	17,456	29,101	75,907	27,114	68,146
1908	255,714	431,551	56,563	18,953	28,109	66,537	23,511	57,561
1909	267,676	418,242	56,911	19,254	31,967	75,656	12,230	29,754
1910	286,226	478,095	59,962	22,658	(b)	(b)	(b)	(b)

[a] Quantity sold.
[b] Figures not yet available.
[c] Exports.

TRADE AND MANUFACTURING CONDITIONS.

The gypsum industry in 1911 was not satisfactory to the majority of producers. As compared with the conditions in 1910 more than half the active firms reported that trade was poorer both in demand and in prices. A few reported a better demand but lower prices. Some producers noted no change in conditions, and a very few reported better trade than in 1910. The general consensus of opinion, however, is accurately reflected in the statistics, already summarized, which show a slight net loss in output and a considerable decline in prices. A large number of plants that have been producers within recent years were idle, and three mills were reported as having burned down during the year. New mills with increased capacity are being built to replace two of these mills.

The close of 1911 showed a total of 78 active mines (including quarries and pits) producing gypsum and gypsite. There were also 78 plants operated in 1911 making either wall plaster or grinding raw gypsum products, or both, compared with 82 plants in operation in 1910. Only plants using gypsum produced in the United States are considered. Some of these plants use foreign gypsum in part, but the quantity of imported gypsum and the products made from it have not been included in the total production recorded nor are the operations of mills considered in this report which use imported gypsum. Four new companies reported production in 1911—the California Gypsum & Plaster Co., at Gypsite, with quarry at Mojave, Kern County, Cal.; the Dakota Plaster Co., at Black Hawk, near Rapid City, S. Dak.; the Fishack Gypsum Co., near Port Clinton, Ohio; and the Wasem Plaster Co., at Fort Dodge, Iowa. The United States Gypsum Co. put in operation at the beginning of 1911 a new mill at Fort Dodge, Iowa, which is reported[1] to be the largest gypsum-products plant in the United States. This mill takes the place of the other plants of the United States Gypsum Co. at Fort Dodge which have from time to time burned down or have been abandoned. It is supplemented by a newly developed mine and by special plants for the manufacture of gypsum partition, tile, and plaster board.

At the close of 1911 five new projects were in various stages of promotion.

During 1911 there were 73 calcining plants in operation, including 3 plants manufacturing Keenes cement. Of these plants 67 were equipped with kettles, 2 with rotary kilns, 3 with stationary kilns and 1 was reported as a baffle-plate furnace. There were 193 calcining kettles in operation, ranging between 6 and 10 feet in diameter but mainly between 8 and 10 feet. The total daily capacity for al these calcining kettles as reported was 14,420 short tons, giving a average of 75 tons per kettle. On comparing these statistics wit those for 1910 it is found that there was a net gain of 2 plants calcining by means of kettles, a net gain of 3 kettles, an apparent gai of 1,120 tons in the total daily capacity, and an increase of 5 tons day in the average daily capacity per kettle. These summaries d not include the equipment of several plants termed "mixing mills' which are auxiliary mills established at commercial centers such a Chicago, Peoria, and Springfield, Ill., Milwaukee and Superior, Wis Minneapolis and St. Paul, Minn., and Cleveland, Ohio. These mill do no calcining, but receive the calcined plaster and prepare it for th market in various forms by the addition of fiber, retarder, sand, etc. The apparent annual plaster-making capacity of the country i according to these figures—the capacity to run full for 300 days bein allowed—about 2.7 times the actual output; but if shutdowns f repairs, equivalent to one-third of the capacity, and 300 working day be allowed for, the apparent capacity is still 1.8 times the productio In all probability the capacities of many mills have been rated too hig

The supply of gypsum for 41 plants was obtained from quarrie for 28 plants it was drawn from mines; and for 8 plants it was derive from both quarries and mines. The raw material used by 54 plan was rock gypsum and by 13 plants it was gypsite, while at 10 plan it consisted of both gypsum and gypsite. The gypsite areas are co fined to the States west of Missouri River, deposits having been work in 1911 in Arizona, California, Kansas, New Mexico, Oklahoma, Texa and Wyoming. The fuel used at 55 calcining plants consisted of coa oil was used at 16 plants; wood at 1 plant; and both coal and wood 1 plant. The oil-burning plants are in the States of Kansas, Okl homa, Texas, Arizona, Nevada, Washington, and California.

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[1] The world's greatest gypsum mill: Rock Products, Dec. 22, 1911, pp. 3, 54.

LIME.

By Ernest F. Burchard.

INTRODUCTION.

Although the volume of business transacted by the lime industry in 1911 was not equal to that of 1910, the proportion of decrease was much smaller than that in many other mineral products, and affords evidence that the lime industry was generally in good condition.

An increasing interest is being taken by lime manufacturers in the improvement of methods of quarrying stone and of handling both the raw materials and the finished product, and in the improvement in the quality of lime and the extension of its uses. The technologic investigations of lime have been continued by the United States Bureau of Standards, and it is expected that a bulletin will soon be issued by that bureau. A few of the preliminary results and the conclusions drawn therefrom were published in Mineral Resources for 1910 (pt. 2, pp. 617–620), and since there was a strong demand for separate chapters on lime from that volume, these data are republished herewith, together with later material on the subject.

A new feature introduced in the present chapter is a summary of the kind of limestone available in the producing States, by counties, accompanied by such chemical analyses as are available.

Accompanying the chapter on the stone industry in 1911 (published elsewhere in Mineral Resources for 1911, part 2) are seven maps which show, in connection with the location of quarries of various kinds of stone, the location of limekilns in all States east of Mississippi River.

PRODUCTION.

The total production of lime in 1911, as reported to the United States Geological Survey, was 3,392, 915 short tons, valued at $13,689,054, as compared with 3,505,954 short tons, valued at $14,088,039 in 1910. This represents a decrease in tonnage of 113,039 tons, and in value of $398,985, or 3.2 per cent and 2.8 per cent, respectively. The average price per ton in 1911 was $4.03, as compared with $4.02 in 1910, or an increase of 1 cent a ton. The total number of producers reporting in 1911 was 1,089, as compared with 1,126 in 1910, a decrease of 37. This decrease in the number of producers was due partly to the inactivity of small kilns operated by farmers for burning lime for local use as fertilizer and partly to the tendency of the industry toward concentration of plants into fewer and larger units. The heaviest decrease in the number of producers was in Pennsylvania, West Virginia, and Wisconsin; other States showed minor decreases; and a few, such as Porto Rico, Texas, and Washington, showed an increase in the number of producers. In 1911, 44 States, including Hawaii and Porto Rico, reported production of lime; in 1910, lime was produced in 43 States. The five leading States in 1911 were, in the order of their production, Pennsylvania, Ohio, Wisconsin, West Virginia, and Missouri. Pennsylvania produced 841,723 short tons of lime in 1911, valued at $2,688,374, the average price being $3.19 per ton. There were 551 active producers in Pennsylvania, including farmers who produced only a few hundred bushels each for fertilizer. The Pennsylvania production represented a decrease in quantity of 35,991 short tons, but an increase in value of $248,024, as compared with 1910, the price increasing 41 cents per ton. In Ohio 405,562 short tons were reported in 1911 valued at $1,607,524, representing a decrease in quantity of 9,723 short tons and in value of $39,811. The average price per tons in 1911 was $3.96, a decrease of 1 cent below the price in 1910. There were 34 producers in Ohio in 1911 as compared with 36 in 1910. In 1911 Wisconsin produced 250,638 short tons of lime, quarried from native rock, valued at $961,558, besides some lime burned from stone imported from other States. The stone imported from other States was mainly high-calcium limestone, the lime from which was used by beet-sugar refiners. The 1911 production in Wisconsin as compared with that of 1910 represented an increase in quantity of 2,400 short tons, and in value of $2,153. The price per ton in 1911 was $3.84, as compared with $3.86 in 1910, and there were 33 producers in 1911 as compared with 40 in 1910. West Virginia produce 179,966 short tons of lime in 1911, valued at $536,660, at an averag price of $2.98 per ton, an increase in quantity of 89,547 tons, and i value of $262,455. In 1911 there were 26 producers as compared wit 37 in 1910. West Virginia showed the largest gain in production i 1911. In 1911 Missouri produced 158,368 short tons of lime, value at $722,563, the average value per ton being $4.56. As compare with the production in 1910 there was a decrese in quantity of 21,18 tons and in value of $123,560, with a decrease in average price per to of 15 cents. The number of operators was two less in 1911.

In 1911 there were 61 manufacturers of hydrated lime, as compare with 52 in 1910, and the production in 1911 was 304,593 short tons valued at $1,372,057, an average price per ton of $4.50, as compare with 320,819 short tons, valued at $1,288,789, or an average price $4.02 per ton in 1910. The quantity of hydrated lime produce therefore decreased 16,226 short tons, while the total value increase $83,268.

The following table gives the value of the total lime production i the United States for the years 1896 to 1903, and the quantity an value of the production from 1904 to 1911, inclusive:

Production of lime in the United States, 1896–1911.

Year.	Quantity.	Value.	Year.	Quantity.	Value.
				Short tons.	
1896	....	$6,327,900	1904	2,707,809	$9,951,456
1897	....	6,390,487	1905	2,984,100	10,941,680
1898	....	6,886,549	1906	3,198,087	12,480,653
1899	....	6,983,067	1907	3,092,524	12,656,705
1900	....	6,797,496	1908	2,766,873	11,091,186
1901	....	8,204,054	1909	3,484,974	13,846,072
1902	....	9,335,618	1910	3,505,954	14,088,039
1903	....	9,255,882	1911	3,392,915	13,689,054

Detailed statistics of the production of lime in 1910 and 1911 are given in the following table:

Quantity and value of lime burned in the United States in 1910 and 1911, by States, in short tons.

1910.

State or Territory.	Rank of State by quantity.	Quantity.	Value.	Rank of State by value.	Average price per ton.	Number of operators.
Alabama	15	81,696	$303,612	13	$3.72	14
Arizona	26	13,728	68,055	26	4.96	4
Arkansas	23	26,532	127,068	23	4.79	8
California	17	63,759	613,242	8	9.62	17
Colorado	31	8,057	40,860	31	5.07	7
Connecticut	11	93,576	417,850	11	4.47	4
Florida	27	10,482	58,386	28	5.57	3
Georgia	32	7,621	29,961	35	3.93	5
Idaho	30	8,094	48,298	29	5.97	7
Illinois	10	113,239	503,581	10	4.45	14
Indiana	14	86,811	301,304	15	3.47	10
Iowa	25	15,481	81,775	25	5.28	4
Kansas	42	1,510	7,503	42	4.97	5
Kentucky	39	3,622	12,468	39	3.44	9
Maine	4	179,656	893,599	4	4.97	7
Maryland	9	121,555	377,236	12	3.10	46
Massachusetts	8	140,942	758,739	6	5.38	10
Michigan	16	72,345	303,377	14	4.19	10
Minnesota	19	45,194	289,227	16	6.40	6
Missouri	5	179,550	846,123	5	4.71	27
Montana	35	4,480	26,925	36	6.01	4
New Jersey	22	34,148	128,964	22	3.78	20
New Mexico	36	4,445	17,930	38	4.03	5
New York	6	146,474	620,564	7	4.24	37
North Carolina	28	9,952	40,455	32	4.07	7
Ohio	2	415,285	1,647,335	2	3.97	36
Oklahoma	41	2,140	9,700	41	4.53	3
Oregon	33	6,742	65,039	27	9.65	10
Pennsylvania	1	877,714	2,440,350	1	2.78	572
Porto Rico	40	2,564	10,160	40	3.96	19
South Dakota	37	4,151	25,399	37	6.12	5
Tennessee	13	88,679	275,701	17	3.10	17
Texas	18	48,200	226,952	20	4.71	10
Utah	24	15,625	88,030	24	5.63	13
Vermont	20	38,667	203,606	21	5.27	9
Virginia	7	141,257	563,567	9	3.99	48
Washington	21	35,540	267,735	19	7.53	10
West Virginia	12	90,419	274,205	18	3.03	37
Wisconsin	3	248,238	959,405	3	3.86	40
Wyoming	43	143	1,783	43	12.47	3
Hawaii	34	17,641	111,970	30	8.56	4
Rhode Island	38			34	8.00	
South Carolina	29			33	4.36	
Total	......	3,505,954	14,088,039	......	4.02	1,126

Quantity and value of lime burned in the United States in 1910 and 1911, by States, in short tons—Continued.

1911.

State or Territory.	Rank of State by quantity.	Quantity.	Value.	Rank of State by value.	Average price per ton.	Number of operators.
Alabama	15	76,406	$300,787	16	$3.94	13
Arizona	25	13,844	69,940	26	5.05	4
Arkansas	23	22,847	109,067	23	4.77	6
California	16	72,858	564,175	7	7.74	18
Colorda	31	6,403	34,614	31	5.41	7
Connecticut	17	69,719	328,904	14	4.72	6
Florida	27	10,867	49,221	27	4.53	3
Georgia	32	6,282	24,067	36	3.83	3
Idaho	30	6,809	38,088	29	5.59	7
Illinois	12	92,169	423,762	11	4.60	14
Indiana	11	92,229	324,950	15	3.52	10
Iowa	24	14,791	80,914	24	5,47	4
Kansas	42	648	3,440	42	5.30	3
Kentucky	36	4.365	15,121	39	3.46	9
Maine	6	152,552	773,212	4	5.07	7
Maryland	10	114,386	362,839	12	3.17	44
Massachusetts	7	137,440	695,662	6	5.06	11
Michigan	14	80,709	352,608	13	4.37	14
Minnesota	19	39,208	242,945	18	6.20	6
Missouri	5	158,368	722,563	5	4.56	25
Montana	38	3,100	18,480	38	5.96	3
New Jersey	22	27,057	113,784	22	4.21	17
New Mexico	41	1,945	13,004	41	6.68	4
New York	9	119,707	524,845	9	4.38	35
North Carolina	28	7,809	33,543	32	4.30	6
Ohio	2	405,562	1,607,524	2	3.96	34
Oklahoma	37	3,472	14,603	40	4.21	4
Oregon	35	4,557	38,216	28	8.39	8
Pennsylvania	1	841,723	2,688,374	1	3.19	551
Porto Rico	33	6,083	26,075	35	4.29	35
South Dakota	34	5,293	37,573	30	7.10	6
Tennessee	13	91,099	282,763	17	3.10	14
Texas	18	43,064	218,007	20	5.06	12
Uath	26	11,681	74,770	25	6.40	13
Vermont	20	37,333	191,035	21	5.12	10
Virginia	8	132,133	483,016	10	3.66	45
Washington	21	35,094	228,933	19	6.52	13
West Virginia	4	179,966	536,660	8	2.98	26
Wisconsin	3	250,638	961,558	3	3.84	33
Hawaii	39	12,699	79,412	34	9.00	6
Nevada	43			43	12.50	
Rhode Island	40			37	8.00	
South Carolina	29			33	4.36	
Wyoming	44			44	12.64	
Total	....	3,392,915	13,689,054	....	4.03	1,08

The Minnesota totals for 1911 include some lime burned in the State from stone shipped by the manufacturers from their Ohio quarries. The stone used for this lime is not included in the chapter on stone production.

In Wisconsin some lime is burned every year that is not included in the lime output, as the limestone from which it is derived is purchased by various lime companies from quarries in Ohio and other places, where high-calcium limestone is available, and the stone for this purpose is included in the reports of the quarries producing it. Some of the lime produced in New York, North Carolina, South Carolina, and Wisconsin is reported as calcined from marl. The New York and Wisconsin marl is probably the fresh-water marl deposited in the bottoms of glacial lakes; that used in the Carolinas is probably a shell marl from the Coastal Plain deposits. These totals also do not include a quantity of lime used by alkali works and sugar factories which burn limestone purchased from various quarries and do not keep a record of the quantity and value of the lime burned. It is probable, therefore, and also because it is not always possible to get replies from every small producer of lime before this report goes to press, that the totals represent slightly less than the total annual output of lime in the United States.

USES OF LIME.

Few mineral products have so wide a variety of uses as lime. Nearly half the lime manufactured in the United States is used as a structural material, and the remainder, amounting to about 1,750,000 tons, valued at about $5,500,000, is consumed in chemical uses. The principal uses which lime has in building operations are in lime mortars and plasters, in gaging Portland cement mortars, concrete, and gypsum plasters, and as a whitewash. Both quick and hydrated lime are used in building operations.

The limes most commonly used fall into the following three general divisions, depending on the chemical composition of the original limestone: (1) High-calcium lime, containing 90 per cent or more of calcium oxide (CaO); (2) magnesian limes, containing 5 to 25 per cent magnesia (MgO), the remainder consisting essentially of calcium oxide; (3) highly magnesian to dolomitic limes, containing 25 to 45 per cent magnesia, the remainder consisting essentially of calcium oxide and impurities such as silica, alumina, and iron oxide. Recent tests[1] have indicated that the magnesian limes are generally best suited to structural work and the high-calcium limes to chemical uses, but for certain uses the reverse of this rule is true, and for many applications in each branch of industry either type of lime is equally well suited.

The chemical uses of lime are much more varied than the uses of lime in building. A number of the industries that are large users of lime are listed below, together with the special purposes served by lime in each industry and the kind of lime most suitable to such purposes.

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[1] Emley, W. E., Tests of lime: Trans. Nat. Lime Mfrs. Assoc., 1911, p. 196.

Chemical uses of lime.[1]

Agricultural industry:
  As a soil amendment, c, m.[2]
  As an insecticide, c, m.
  As a fungicide, c, m.
Bleaching industry:
  Manufacture of bleaching powder, "Chloride of lime," c.
  Bleaching and renovating of rags, jute, ramie, and various paper stocks, c, m.
Caustic alkali industry:
  Manufacture of soda, potash, and ammonia, c.
Chemical industries:
  Manufacture of ammonia, c.
  Manufacture of calcium carbide, calcium cyanimid, and calcium nitrate, c.
  Manufacture of potassium dichromate and sodium dichromate, c.
  Manufacture of fertilizers, c. m.
  Manufacture of magnesia, m.
  Manufacture of acetate of lime, c.
  Manufacture of wood alcohol, c.
  Manufacture of bone ash, c. m.
  Manufacture of calcium carbides, c.
  Manufacture of calcium-light pencils, c.
  In refining mercury, c.
  In dehydrating alcohol, c.
  In distillation of wood, c.
Gas manufacture:
  Purification of coal gas and water gas, c, m.
Glass manufacture:
  Most varieties of glass and glazes, c.
Milling industry:
  Clarifying grain, c, m.
Miscellaneous manufactures:
  Rubber, c, m.
  Glue, c, m.
  Pottery and porcelain, c, m.
  Dyeing fabrics, c, m.
  Polishing material, c, m.
Oil, fat, and soap manufacture:
  Manufacture of soap, c.
  Manufacture of glycerine, c.
  Manufacture of candles, c.
  Renovating fats, greases, tallow, butter, c, m.
  Removing the acidity of oils and petroleum, c, m.
  Lubricating greases, c, m.
Paint and varnish manufacture:
  Cold-water paint, c, m.
  Refining linseed oil, c, m.
  Manufacture of linoleum, c, m.
  Manufacture of varnish, c, m.
Paper industry:
  Soda method, c.
  Sulphite method, m.
  For strawboard, c, m.
  As a filler, c, m.
Preserving industry:
  Preserving eggs, c.
Sanitation:
  As a disinfectant and deodorizer, c.
  Purification of water for cities, c.
  Purification of sewage, c.
Smelting industry:
  Reduction of iron ores, c, m.
Sugar manufacture:
  Beet root, c.
  Molasses, c.
Tanning industry:
  Tanning cowhides, c.
  Tanning goat and kid hides, c, m.
Water softening and purifying, c.

The following table gives the total lime marketed in 1910 and 1911 classified according to its consumption in certain general industries as reported by the producers. As much of the product is handled by dealers or middlemen, the manufacturers are uncertain as to what use was made of their product and this table is therefore necessarily faulty, but it is of interest as showing a comparative table of sales for the two years. Each manufacturer, as a rule, classifies his output similarly from year to year.

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[1] Notes on the part played by lime in these industries are given in Circular No. 30 of the Bureau of Standards, 1911, pp. 13–21.

[2] High calcium lime is indicated by "c," magnesian and dolomitic lime by "m."

Production of lime in the United States in 1910 and 1911, by uses, in short tons.

1910.

	Quantity.	Value.	Average price per ton.
Building lime	6,746,662	$7,526,914	$4.30
Alkali works	10,644	40,127	3.72
Chemical works	182,043	696,313	3.82
Paper mills	286,922	1,079,556	3.76
Sugar factories	29,421	239,536	8.14
Tanneries	28,921	133,640	4.62
Fertilizer	585,876	1,739,308	2.93
Dealers—uses not specified	496,930	2,120,685	4.27
Other uses [a]	138,535	511,960	3.70
Total	3,505,954	14,088,039	4.02
Hydrated lime, included in total	320,819	1,288,789	4.02

1911.

	Quantity.	Value.	Average price per ton.
Building lime	1,488,567	$6,755,889	$4.54
Alkali works	6,179	24,696	4.00
Chemical works	256,215	933,957	3.65
Paper mills	286,485	1,107,879	3.87
Sugar factories	36,424	242,344	6.65
Tanneries	30,167	138,352	4.59
Fertilizer	596,664	1,714,386	2.87
Dealers—uses not specified	531,249	2,202,286	4.15
Other uses [a]	160,965	569,265	3.54
Total	3,392,915	13,689,054	4.03
Hydrated lime, included in total	304,593	1,372,057	4.50

[a] Includes lime for sand-lime brick, slag cement, steel works, glass works, smelters, sheep dipping, disinfectant, manufacture of soap, cyanide plants, glue factories, purification of water, etc.

HYDRATED LIME.

Definition.—When quicklime is slaked, by whatever process, whether in the simple mortar box by adding water by the bucketful and stirring with a hoe, or whether the lime and water are automatically weighed out in definite parts and the mass is stirred by machinery, the chemical principle involved is the same, viz, quicklime plus water becomes slaked lime, or hydrated lime—

$$CaO + H_2O = Ca(OH)_2,$$

or, if the limestone used for making quicklime contains magnesia, the following equasion is appropriate: Magnesian quicklime plus water becomes slaked or hydrated magnesian lime—

$$CaO.MgO + H_2O = Ca(OH)_2.MgO.$$

Commercially the term "hydrated lime" is restricted to the dry powder prepared by treating quicklime with just enough water to combine with all the calcium oxide present. In the preparation of hydrated lime two materials only are used—fresh caustic lime and water. The general method of preparation is first to reduce the lumps of lime by crushing to about $\frac{1}{2}$-inch size. In some plants this reduction is carried further by grinding the lime to about the fineness of granulated sugar. The crushed or granulated lime is then treated with sufficient water to combine chemically with the calcium oxide in the lime, care being taken that the quantity is neither too little to satisfy the chemical requirements nor so great as to leave the hydrated mass wet or even damp. In practice, an excess of water is used, but this excess is driven off by the heat generated in the slaking or hydrating of the lime. The object of crushing the product is to produce a larger surface for the action of the water, and, moreover, large lumps would be rather unwieldy in the hydrater. The lime comes from the hydrater as a fine, dry powder, which must be screened to remove any coarse or overburned lime that would not slake. From the screens it goes to the storage bin, where, if the capacity is available, it is at some plants allowed to age for 30 days. Finally, the product is fed into bags for shipment. The equipment of the hydrating plant generally includes two elevators, one to take the lime from the crusher to the bin over the hydrater and one to take the hydrated lime from the hydrater to the storage bin. Most mills include, also, a machine for grinding the oversize from the screens. This material consists of unburned stone, overburned lime, lime which is not fully hydrated, and even pieces of brick from the kilns, and coal ashes. When ground, the tailings may be sold for fertilizer. The methods of manufacture most extensively employed in this country are the batch process, the continuous process, and modifications of these two processes.

The following table shows the number of lime-hydrating plants reported to the survey as operating in the United States during the last five years, and draws attention to the steady development of this phase of the lime industry:

Number of lime-hydrating plants in operation in 1906–1911, by States.

State or Territory.	1906	1907	1908	1909	1910	1911
Alabama	1	1	1	3	2	2
Arizona	1	1	1	1	1	1
California		1	2	2	2	3
Colorado		1		1	1	
Connecticut	1			1		
Florida			1		1	
Georgia	2	1	1			1
Hawaii					1	
Idaho				1	1	1
Illinois		1	1	2	2	2
Indiana	2	2	2	2	2	2
Iowa	1			1		
Kansas	1	1		1		
Maine	1	1	1	1	1	1
Maryland			1	1	3	3
Massachusetts					1	2
Michigan	1	1	2	1	2	3
Missouri		2	2	3	3	3
New Jersey			1	1		2
New York	1	2	2	3		2
North Carolina						1
Ohio	8	9	11	8	11	15
Pennsylvania	8	6	11	9	8	8
Porto Rico					1	
South Dakota					1	1
Tennessee			1	1	1	1
Texas			1	3	3	3
Virginia			1	2		1
Washington						1
West Virginia	1	1	1		2	1
Wisconsin	1	2	2	2	2	1
Total	30	33	46	50	52	61

Production.—The production of hydrated lime in 1911, as reported to the Survey, was 304,593 short tons, valued at $1,372,057, or $4.50 per ton, as compared with 320,819 short tons, valued at $1,288,789, in 1910. The decrease in quantity in 1911, as compared with 1910, amounted to 16,226 short tons, or about 5 per cent, but the increase in value amounted to $83,268, or nearly 6.5 per cent, and the increase in value per ton was 48 cents, or nearly 12 per cent. Almost from its beginning the production of hydrated lime has shown a steady annual increase, but in 1911, in common with nearly all of the manufactures dependent on mining and quarrying, the production of hydrated lime suffered a slight reduction. This can hardly be regarded as a setback to the industry, however, in the light of the relatively large increase in price of the product.

The following table shows the quantity and value of the hydrated lime produced in the United States from 1906 to 1911, inclusive, together with the average price per ton and the total number of manufacturers reporting to the Survey:

Production of hydrated lime in the United States, 1906–1911, in short tons.

Year.	Quantity.	Value.	Average price per ton.	Number of plants reporting operations.
1906	120,357	$479,079	$3.98	30
1907	140,135	657,636	4.69	33
1908	136,441	548,262	4.02	46
1909	204,611	904,900	4.43	50
1910	320,819	1,288,789	4.02	52
1911	304,593	1,372,057	4.50	61

IMPORTS.

The imports of lime for consumption in the United States in 1911 were reported by the Bureau of Statictics as 5,232 short tons, valued at $55,255, as compared with 6,498 short tons, valued at $63,791, in 1910, a decrease in quantity of 1,266 tons and in value of $8,536.

EXPORTS.

In 1911 there were exported from the United States 207,232 barrels of lime, valued at $153,212, as compared with 164,602 barrels, valued at $127,952, in 1910.

FUELS.

Lime is burned with a number of different fuels. The single fuel used most extensively by lime kilns in the United States at present is coal, followed by wood, producer gas, coke, oil, and natural gas. A large variety of mixtures is also employed, such as coal and coke, coal and wood, coke and wood, coke and shavings, and shavings and manure. At some plants different kilns are equipped to use different fuels, but the reports received by the Survey are very incomplete as to details.

It is probable that if wood were universally abundant it would be more generally used than coal. Lime can generally be burned more slowly and at a lower temperature with wood than with other fuels. The lower the temperature at which a lime is burned the better its quality will be, since the activity of the impurities is less the lower the temperature is. Moreover, the minimum temperature for the decomposition of calcium carbonate may be decreased by the introduction of steam into the kiln. The presence of steam in the gases of combustion from wood, therefore, tends to produce a better quality of lime.

With the diminution in the supply of wood, gaseous fuels that may be closely controlled have begun to increase in use, and at present there seems to be considerable interest in the possibilities of producer gas.

A general statistical inquiry relating to the efficiency of coal as a fuel in burning lime was made by the Survey at the close of 1911. The nature of the inquiry was not sufficiently specific nor detailed to bring out the conditions under which the results as reported were obtained, but considerable information was volunteered by producers, which added to the value of some of the reports. On the other hand, not all the producers replied to the inquiry, consequently the data at hand are incomplete, and no reliable averages can be made. Many of the answers were evidently based on observations and measurements, but others were apparently mere guesses. The reports on the quantity of lime burned from 1 pound of coal ranged from 1.2 pounds to 8 pounds. Maxima of 6, 7, and 8 pounds were reported by a very few producers, so few, indeed, as to cause these figures to be regarded as anomalous. Four to five pounds of lime were reported by a few producers as burned from 1 pound of coal, and in the majority of these cases gas coal was specified. The great majority of reports gave from 2.5 to 4 pounds of lime burned from 1 pound of coal. In most cases the coal was of fine sizes, such as pea coal, rice coal, and slack, but in some kilns run-of-mine and screened nut coal was burned. Reports which mentioned the Eldred process as being employed showed a production of from 3 to 5 pounds of lime per pound of coal, with the results averaging closer to 5 pounds than to the lower figure.

Reports as to coke as fuel gave a range of from 4 to 6 pounds of lime to 1 pound of coke. Several manufacturers who use producer gas reported their fuel consumption in terms of coal, and the range in reports showed from 2.5 to 5 pounds of lime burned by 1 pound of coal converted into producer gas. The average apparently was about 4 pounds. No definite figures were received for wood-burned lime.

There are no data on fuels used in 1910 that can be directly compared with those presented for 1911. In 1910 the number of lime-manufacturing plants, so far as could be ascertained, that used the above-mentioned fuels were tabulated. An attempt has been made to differentiate the number of kilns in 1911, but the data are not satisfactory, owing principally to the fact that not all of the producers answered the question asking for this information.

The following table shows the kinds of fuel and the number of kilns using the various fuels as reported in 1911:

Number of kilns using various kinds of fuel, by States, in 1911.

State or Territory.	Coal.	Wood.	Oil.	Natural gas.	Producer gas.	Coke.	Shavings.	Coal and wood.	Coal and coke.	Mixed fuel, kind not stated.	Total number of kilns.
Alabama	9	3			8			30		1	51
Arizona		3									3
Arkansas		6									6
California		9	32			3					44
Colorado	6										6
Connecticut	5	23			8						36
Florida		14									14
Georgia								1			1
Hawaii			2								2
Idaho	4	6									10
Illinois	4	7			1		26	9			47
Indiana	46	2	3		2			1		2	56
Iowa	3	2									5
Kansas	1		3	1							5
Kentucky	3	5									8
Maine	43	20									63
Maryland	54	1	2			13		[a] 5	11		86
Massachusetts	20	16			3			15			54
Michigan	8	28									36
Minnesota	21	5									26
Missouri	32	43			2			10		4	91
Montana		4									4
Nevada			1								1
New Jersey	46	1						4			51
New Mexico	2	2									4
New York	19	5			1			2			27
North Carolina		4									4
Ohio	192	3	2	24	26						247
Oklahoma		10									10
Oregon		7									7
Pennsylvania	632	6		5	10	16	1	[a] 133	24	6	833
South Carolina	3										3
South Dakota		7						1			8
Tennessee	19	5				2					26
Texas		14	6	2	4					2	28
Utah	9	4				9					22
Vermont	18							9			27
Virginia	34	19			2	9		15			79
Washington		27									27
West Virginia	11	1		1	3	18		[a] 7			41
Wisconsin	3	80			1			4			88
Wyoming	1										1
Total	1,248	392	51	33	71	70	27	246	35	15	2,188

[a] Includes kilns using also some oil.

DISTRIBUTION OF LIMESTONE.

Lime was burned in 42 States, besides in Hawaii and Porto Rico. The States from which no production of lime was reported were Delaware, Louisiana, Mississippi, Nebraska, New Hampshire, and North Dakota, and none was reported from Alaska or the District of Columbia. Each of the producing States possesses local supplies of limestone, and there are also undeveloped areas of limestone in Alaska, Louisiana, Mississippi, Nebraska, and North Dakota, or, in other words, limestone is almost universally distributed throughout the United States. High-calcium limestone that is suitable for the manufacture of Portland cement is generally suitable for the manufacture of lime, provided the impurities such as silica and alumina are not too high. The distribution by States of the principal high-calcium limestone deposits is outlined, accompanied by a map (in pocket), in Mineral Resources for 1910, part 2, pages 488-532, and will soon be published in greater detail in Bulletin 522 of the Survey, on the Portland cement materials of the United States. Lime manufacturers, for the most part, reported in connection with the statistics of production of lime in 1911 whether their product is a high-calcium or a magnesian lime, and the following table gives the results of these reports, enumerated by States and counties:

Character of lime produced in the United States in 1911, by States and counties.

State or Territory.	County.	
	High-calcium lime.	Magnesian lime.
Alabama	Blount	Colbert.
	Calhoun	
	Etowah	
	Jefferson	
	Madison	
	Shelby	
Arizona	Yavapai	
Arkansas	Benton	
	Izard	
	Washington	
California	Amador	Siskiyou.
	Contra Costa	
	Eldorado	
	Kern	
	Los Angeles	
	Mono	
	Placer	
	San Bernardino.	
	Santa Cruz	
	Shasta	
	Siskiyou	
	Tuolumne	
	Ventura	
Colorado	Chaffee	Boulder.
	Douglas	Fremont.
Connecticut	Fairfield	Fairfield.
		Litchfield.
Florida	Marion	
Georgia	Walker	Bartow.
Hawaii	Hawaii	
Idaho	Bannock	
	Kootenai	
	Lemhi	
	Nez Perce	
	Oneida	
Illinois	Adams	Cook.
	Madison	Kankakee.
	Will	Rock Island.
		Whiteside.
		Winnebago.
Indiana	Carroll	Huntington.
	Crawford	Jay.
	Lawrence	Jefferson.
	Ripley	
	Washington	
Iowa	Cerro Gordo	Dubuque.
	Clayton	
Kansas	Leavenworth	Shawnee.
Kentucky	Breckinridge	Warren.
	Meade	
	Rockcastle	
	Scott	
Maine	Knox	Knox.
Maryland	Allegheny	Baltimore.
	Baltimore	Carroll.
	Carroll	Frederick.
	Frederick	
	Garrett	
	Howard	
	Washington	
Massachusetts	Berkshire	Berkshire.
Michigan	Bay	Bay.
	Charlevoix	Emmet.
	Emmet	Menominee.
Michigan	Mackinac	Schoolcraft.
	Schoolcraft	
	Wayne	
Minnesota	Mower	Blue Earth.
	Scott	
Missouri	Callaway	Cole.
	Cape Girardeau.	
	Cooper	
	Dade	
	Franklin	
	Greene	
	Jasper	
	Jefferson	
	Lawrence	
	Marion	
	Miller	
	Pettis	
	Pike	
	St. Clair	
	St. Genevieve.	
	St. Louis	
Montana	Powell	Park.
New Jersey	Hunterdon	Hunterdon.
	Sussex	Somerset.
	Warren	Warren.
New Mexico	San Miguel	Grant.
		San Juan.
New York	Clinton	Albany.
	Fulton	Dutchess.
	Genesee	Jefferson.
	Jefferson	Ulster.
	Lewis	Westchester.
	Livingstone	
	Monroe	
	Onondaga	
	St. Lawrence	
	Ulster	
	Warren	
	Washington	
North Carolina	Craven	
	Henderson	
	Yadkin	
Ohio	Delaware	Clark.
	Erie	Greene.
	Holmes	Hardin.
	Marion	Ottawa.
	Ottawa	Sandusky.
	Preble	Seneca.
	Stark	Wood.
	Tuscarawas	Wyandot.
Oklahoma	Coal	Delaware.
Oregon	Baker	
	Jackson	
	Josephine	
	Wallowa	
Pennsylvania	Adams	Armstrong.
	Armstrong	Berks.
	Bedford	Chester.
	Berks	Cumberland
	Blair	Dauphin.
	Bucks	Huntingdon
	Butler	Jefferson.
	Center	Juniata.
	Clarion	Lancaster.

Character of lime produced in the United States in 1911, by States and counties—Contd.

State or Territory.	County.	
	High-calcium lime.	Magnesian lime.
Pennsylvania	Clinton	Lebanon.
	Columbia	Lehigh.
	Cumberland	Lycoming.
	Dauphin	Montgomery.
	Fayette	Montour.
	Franklin	Northampton.
	Huntingdon	Northumberland.
	Jefferson	Perry.
	Juniata	Union.
	Lancaster	Westmoreland.
	Lawrence	York.
	Lebanon	
	Lycoming	
	Montgomery	
	Montour	
	Northampton	
	Northumberland.	
	Perry	
	Snyder	
	Union	
	Westmoreland	
	York	
Rhode Island		Providence.
South Dakota	Custer	Meade.
	Lawrence	
	Meade	
	Pennington	
Tennessee	Carter	Rhea.
	Coffee	
	Cumberland	
	Davidson	
	Dickson	
	Franklin	
	Houston	
	Knox	
	Lawrence	
	Rhea	
	Union	
	Washington	
Texas	Comal	Coryell.
	Coryell	El Paso.
	El Paso	Tarrant.
	Nolan	
	Travis	
Utah	Cache	Salt Lake.
	Salt Lake	Wasatch.
	San Pete	
	Sevier	
Vermont	Addison	Windsor.
	Chittenden	
	Franklin	
	Rutland	
	Windham	
Virginia	Augusta	Augusta.
	Botetourt	Frederick.
	Giles	Loudoun.
	Rockbridge	Montgomery.
	Rockingham	Rockbridge.
	Shenandoah	
	Tazewell	
	Warren	
	Washington	
Washington	Chelan	Stevens.
	Ferry	
	Okanogan	
	San Juan	
	Stevens	
	Whatcom	
West Virginia	Berkley	Berkley.
	Greenbrier	Jefferson.
	Jefferson	Preston.
	Preston	Wayne.
Wisconsin	Door	Buffalo.
	Lafayette	Calumet.
	Waukesha	Dodge.
		Door.
		Fond du Lac.
		Kewaunee.
		Manitowoc.
		Ozaukee.
		Sheboygan.
		Washington.
		Waukesha.

ANALYSES.

From year to year many producers of lime and limestone who correspond with the Survey courteously send with their reports of production records of chemical analyses of their products. Enough of such data are now in hand to permit their publication, and the following analyses of limestones and limes are given for the purpose of affording general information as to the character of the available limestones in certain localities and of some of the limes manufactured in the United States.

The analyses are not as complete as the classification of limestones given in the foregoing list, but they correspond in a general way with the classes of stone distributed by counties.

Analyses of limestone quarried in the United States, by States.

Location.	Operator or owner.	Authority.	Calcium carbonate ($CaCO_3$).	Magnesium carbonate ($MgCO_3$).	Calcium oxide (CaO).	Magnesium oxide (MgO).	Carbon dioxide (CO_2).	Ferric oxide (Fe_2O_3).	Aluminum oxide (Al_2O_3).	Silica (SiO_2).	Other minerals.	Total.
ALABAMA.												
Blount County:			*Per ct.*	*Per ct.*	*Per ct.*	*Per cr.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*		*Per ct.*
Bangor	Birmingham Ore Co.	Company chemist	96.00					2.00		2.00		100.00
Blount Springs	Blount Lime & Quarry Co.	Dr. W. B. Phillips, Birmingham, Ala.	99.10					.40		.50		100.00
Village Springs	Republic Iron & Steel Co.	Company chemist	93.00	3.00					2.00	2.00		100.00
DeKalb County:												
Battelle	Lookout Mountain Iron Co.	do	95.44	.90				1.16		1.82		99.32
Etowah County:												
Anniston	Anniston Lime Co.	William Makemson, Anniston.	98.76	Trace.				.36		.74		99.86
Lagarde	Lagarde Lime & Stone Co.	Froebling & Robertson	98.36	.65					.36	.62		99.99
Do	do	Chemist So. States Portland Cement Co.	98.32	.81						*a* .92		100.05
Rock Springs	Alabama Consolidated Coal & Iron Co.	Company chemist	97.34					.81		1.23		99.38
Do	do				42.84	7.41	44.55	2.04		*a* 3.16		100.00
Do	Etowah Stone & Ore Co.	Chemist, Southern Iron & Steel Co., Alabama City.	89.73	8.33				.66		.78		99.50
Do	do	do	82.23	15.14				.91		1.47		99.75
Franklin County:												
Rockwood	Foster-Creighton Co.	Watertown Arsenal			54.20	1.23	42.61	1.45		.50		99.99
Jefferson County:												
Birmingham	Dolcito Quarry Co.	D. Z. Cauble	55.40	43.15						*a* 1.45		100.00
Do	Southern Iron & Steel Co.	Chemist, Sloss Iron & Steel Co.	57.20	41.42					.64	.74		100.00
Do	do	W. B. Phillips, Birmingham.	56.10	41.16				.30	.80	1.10		99.46
Do	do	David Hancock	58.54	39.84					.84	.78		100.00
Do	do	Company chemist	56.25	38.20				1.13	.80	1.92	P_2O_5, 0.007 per cent; MnO_2, trace; SO_3, 0.01 per cent.	98.317
Do	Tennessee Coal, Iron & Ry. Co.	do	58.50	38.50				.50	1.00	1.50		100.00
Dale	Republic Iron & Steel Co.	R. N. King			50.94	2.18	*b* 42.39		1.75	2.74		100.00

											per cent.	
Ketona	Tennessee Coal, Iron & Ry. Co.	J. R. Harris			31.62	19.58	b 47.47	.18	.26	.89		
Thomas	Republic Iron & Steel Co.	Company chemist	54.44	42.76					1.80	1.00		100.00
Do	do	R. N. King			30.92	19.55	b 45.76		1.47	2.30		100.00
Woodlawn	Leak Lime Co		99.58	.13				.09	.03	.11	H_2O, 0.04 per cent; undetermined, 0.02 per cent.	100.00
Shelby County:												
Calcis	Turner Bros	John Foster, Woodward.	98.86	.71				.15		.34		100.00
Calera	O'Neal Lime Works	F. W. Miller, Birmingham.	99.27	.32				.07	.12	.17	H_2O, trace; H_2SO_4, trace; organic, 0.05 per cent.	100.00
Long View	Long View Lime Works	Eugene A. Smith, State Geologist.	99.11	.75				.13		.39	MnO_2, trace	100.38
Do	do	do	99.16	.75				Trace.		.15	MnO_2, trace	100.06
Saginaw	Bowden Lime Works	J. C. Long, laboratory, Birmingham.	99.58	.13				.09	.03	.11	H_2O, 0.04 per cent; undetermined, 0.02 per cent.	100.00
Talladega County:												
Gantts Quarry	Alabama Marble Co	E. N. Miller	99.41	.40				.10		.29		100.20
Stemley	Northern Alabama Coal, Iron & Ry. Co.	Company chemist	57.14	40.35				1.26		1.25		100.00
Talladega	Talladega Marble Co. (white, dark-blue).	R. S. Hodges, State chemist.	97.86 95.90	1.92 1.00				.23 .29		a 1.32 a 3.72		101.33 100.91
Wynette	Northern Alabama Coal, Iron & Ry. Co.	Chemist, Tennessee Coal, Iron & Ry. Co.	98.75	.75						Trace.	SO_3, trace; P, trace	99.50
ARIZONA.												
Cochise County:												
Douglas	Copper Queen Consolidated Mining Co.	Company chemist			53.00	1.00	b 42.00		1.00	3.00		100.00
Do	do	do			51.00	2.00	b 41.40	.60	1.00	4.00		100.00
Do	do	do			51.80		b 41.80	.40	1.50	4.50		100.00
Yavapai County:												
Humboldt	Colsolidated Arizona Smelting Co.	T. W. Woodbridge, Humboldt.			51.00		b 38.80	.20		10.00		100.00
Do	do	do			36.50	13.20	b 45.50	1.80		3.00		100.00
Do	do	do			49.00	Trace.	b 39.50	.30		(a)		100.00
Do	do	do			52.00	3.20	b 43.40	.20		(a)		100.00
Do	do	do			54.50	.70	b 44.30	.50		a Trace.		100.00
Do	do	do			37.20	9.20	b 48.60	.60		a 4.40		100.00
Do	do	do			52.50	Trace.	b 43.10	.40		a 4.00		100.00

a Insoluble in acid.

b By difference.

Analyses of limestone quarried in the United States, by States—Continued.

Location.	Operator or owner.	Authority.	Calcium carbonate ($CaCO_3$).	Magnesium carbonate ($MgCO_3$).	Calcium oxide (CaO).	Magnesium oxide (MgO).	Carbon dioxide (CO_2).	Ferric oxide (Fe_2O_3).	Aluminum oxide (Al_2O_3).	Silica (SiO_2).	Other minerals.	Total.
ARKANSAS.												
Benton County:												
Rogers	Rogers White Lime Co.	W. A. Powers, Topeka, Kans.	*Per ct.* 99.77	*Per ct.* Trace.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.* 0.35	*Per ct.*	*Per ct.* 0.40		*Per ct.* 100.52
Izard County:												
Guion	White River Lime & Stone Co.	J. C. Branner	97.67									97.67
Do	do	do	99.68									99.68
Washington County:												
Johnson	Ozark White Lime Co.	Laboratory Arkansas State University.		99.34					0.17	*a*.39	H_2O, 0.10 per cent	100.00
CALIFORNIA.												
Amador County:												
Ione	Amador County Lime Kilns.	J. O. Blowski, Oakland.	97.78			Trace.		.72		1.39		99.89
Calaveras County:												
Campo Seco	Penn Mining Works	F. Baird			47.20		*b*47.20	1.40		4.20		100.00
Contra Costa County:												
Berkeley	Martinez Bros.	Smith, Emery & Co., San Francisco.			55.11	.35	*c*43.20	0.40	.80	.24		100.10
Inyo County:												
Inyo	Inyo Consolidated Marble Co.	Geo. P. Merrill, U. S. National Museum.	54.25	44.45						.60		99.30
Do	Inyo Marble Co	California State University.	31.012	21.791			47.353	.017				100.173
Orange County:												
Corona	Lee Kroonen	F. W. Huber, University of California.			51.55	1.86	*c*43.08	1.95		1.35	Undetermined, 0.22 per cent.	100.01
Placer County:												
New Castle	The Holmes-Lime Lands, Cons.		96.12					.11				96.23
San Bernardino County:												
Colton	California Portland Cement Co.	E. Duryee			55.216		43.384		.850	.55		100.00
Do	do	W. C. Hanna, Colton	97.18	2.74				.13		*a*.33		100.38
Santa Barbara County:												
Betteravia	Union Sugar Co	Company chemist	97.55	1.50				.36		.76	H_2O, 0.13 per cent	100.30
Santa Clara County:												
Los Gatos	Stauffer Chemical Co.	E. W. Hilgard, University of California.	96.00	.77				1.00		2.00		99.77
								.90		3.87	Asphalt, 0.69 per cent	100.07

Santa Cruz County:												
Davenport	Santa Cruz Portland Cement Co.	do	95.97			1.34		.60	.73	1.42		100.06
Santa Cruz	L. W. Coffee	Smith, Emery & Co., San Francisco.	95.00									95.00
Shasta County:												
Kennett	Noble Electric Steel Co.		97.57	.76				.52	.64	*a* .41		99.90
Do	do		97.65	.72				.45	.41	*a*.40		99.63
Siskiyou County:												
Gazelle	Mount Shasta Lime Co.		94.69					.99		4.32		100.00
COLORADO.												
Chaffee County:												
Salida	The Ohio & Colorado Smelting and Refining Co.	J. H. Finger			53.00		*b*46.00			1.00		100.00
Do	do				51.90		*b*45.90	.30		1.90		100.00
Eagle County:												
Eagle		C. T Kennan	87.20			1.18		3.48		8.00		99 86
Do		do	51.40			Trace.		9.93		36.77	Organic matter, 0.87 per cent.	98.97
Do		do	88.00			1.22		3.26		7.30		99.78
Do		do	61.78			2.31		9.68		23.32		97.09
El Paso County:												
Manitou	United States Lime Co.	Laboratory, Globe Smelter, Denver.	96.70	1.50				.50		.30	$BaSO_4$, 1 per cent	100.00
Fremont County:												
Calcite	Colorado Fuel & Iron Co.	J. Cambier, Pueblo			53.07	1.56	*c*41.77	1.05		2.49	S, 0.030 per cent; P, 0.0042 per cent.	99.9742
Howard	do	Chemist, American Beet Sugar Co.	96.13	.61				.47		2.53	S, trace	99.74
Gunnison County:												
Marble	Colorado Yale Marble Co.		99.76							.24		100.00
Pueblo County:												
Lime	Colorado Fuel & Iron Co.	J. Cambier, Pueblo			51.60	.57	*c*41.00	2.44		4.08	P, 0.035 per cent; S, 0.056 per cent.	99.781
Livesey	Pueblo Lime & Quarrying Co.	Laboratory, American Beet Sugar Co.	93.93	Trace.				1.40		*a*3.64	Undetermined, 1.03 per cent.	100.00
Pueblo	do		91.24					.89		5.56		97.69
CONNECTICUT.												
Fairfield County:												
Danbury	Stearns Lime Co		55.14	.14			43.51		.11	*a*1.10		100.00
Do	do		54.22	.35			42.69		.28	*a*2.46		100.00
Do	do		54.46	.60			42.99		.15	*a*1.80		100.00
Do	do		31.70	20.25			46.17		.28	*a*1.60		100.00

[a] Insoluble in acid.

[b] By difference.

[c] Includes H_2O.

Analyses of limestone quarried in the United States, by States—Continued.

Location.	Operator or owner.	Authority.	Calcium carbonate ($CaCO_3$).	Magnesium carbonate ($MgCO_3$).	Calcium oxide (CaO).	Magnesium oxide (MgO).	Carbon dioxide (CO_2).	Ferric oxide (Fe_2O_2).	Aluminum oxide (Al_2O_3).	Silica (SiO_2).	Other minerals.	Total.
CONNECTICUT—contd.												
Litchfield County:			*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*		*Per ct.*
Canaan	New England Lime Co.	J. S. Adams	54.40	45.12				0.25		0.08		99.85
East Canaan	Connecticut Lime Co.	Company chemist	54.00	44.00				1.00		*a* 1.00		100.00
Do	New England Lime Co.	Connecticut Agricultural Experiment Station.			31.31	21.03	46.98	.20		.48		100.00
GEORGIA.												
Bartow County:												
Cartersville	Ladd Lime Co	State mineralogist	56.02	38.43				1.50		1.94		97.89
Cherokee County:												
Holly Springs	Georgia Verde Antique Marble Co.	Mariner & Hoskins				34.41	*b*20.75	3.60	5.54	28.80	FeO, 4.75 per cent; Cr, 0.33 per cent; undetermined, 1.82 per cent.	100.00
Dade County:												
Rising Fawn	Georgia Steel Co	Company chemist	92.15			3.40			1.50	2.70		99.75
Gilmer County:												
Gartrell	Gartrell Marble Co	Park, Davis & Co., Detroit, Mich.			48.31	2.72	*b*44.58	4.07		.31		99.99
Hall County:												
Gainesville	C. L. Deal	State chemist	54.47	41.38				1.18		2.89		99.92
Pickens County:												
Marble Hill	Southern Marble Co	L. P. Kinnicut, Worcester, Mass.	98.96					.22		*a* .61	Undetermined and loss, 0.08 per cent.	99.87
Tate	Georgia Marble Co	Jno. C. Jackson, Chicago, Ill.	97.32	1.60					.25	.62	FeO, 0.26 per cent	100.00
Do	do	Georgia Geological Survey.			54.06	.90	*b*42.86	.10		*a* 2.12		100.04
Do	do	do			55.00	1.12	*b*44.16	.15		*a* .35		100.78
Do	do	do			54.41	.75	*b*43.13	.32		*a* 1.62		100.23
Whitestone	Whitestone Marble Co.	N. P. Pratt Laboratory, Atlanta.	58.76	38.69					.36	*a* 3.15	FeO, 0.33 per cent	101.29
Walker County:												
Rossville (Dixie)	Chickamaugna Cement Co.	C. M. Clark, Chattanooga, Tenn.	64.03	4.58				2.64	6.05	22.04		99.34
Do. (Marion)	do	do	74.53	3.80				1.86	1.17	17.14		98.50
IDAHO.												
										a 1.90	SO_3, 0.10 per cent	100.65

Do	do	Sugar City Laboratory	[c]97.40		54.52	.34	[b]43.34	.34		.09 [a]1.34	do	100.07
Bonner County:												
Ponderay	Idaho Smelting & Refining Co.	C. W. Lauer	89.00	4.20				.80	.80	3.20		98.00
Cassia County:												
Burley	Barrett Lime Co.	W. H. Tremaine, Salt Lake City, Utah.	97.20					Trace.	Trace.	1.00		98.20
Nez Perce County:												
Orofino	Clearwater Lime Co.		90.70	8.12				Trace.	.27	.35		99.44
Taplin	West Coast Portland Cement Co.	Hildebrandt & Steiger.	98.85	.20					1.43			100.48
Do	do	do	[c]98.83	.21	55.34	.10	43.59	.10		.39		99.73
Oneida County:												
Franklin	Amalgamated Sugar Co.		93.56	3.88				.30		1.78	H_2O, 0.08 per cent; undetermined, 0.40 per cent.	100.00
Do	Le Roy Quarry Co.	Chemist, Lewiston Sugar Factory.	97.35	.59				.70		1.74		100.38
ILLINOIS.												
Adams County:												
Marblehead	Marblehead Lime Co.	N. Gray Bartlett, Chicago.	95.62	.82				2.18		.47	Undetermined, 0.91 per cent.	100.00
Do	do	Wm. Brady	97.40	1.40				.12	.68	.40		100.00
Do	do	do	97.51	1.30				.12	.52	.50		99.95
Boone County:												
Belvidere	Electric Stone Co.	W. W. Daniels, University of Wisconsin.	52.27	44.67				.98		[a]1.87		99.79
Do	do	do	54.59	41.33				.85		[a]2.90		99.67
Cook County:												
Chicago	Artesian Stone & Lime Co.											
Do	Average of quarry	T. C. Hopkins, State College, Pa.	53.70	42.34				1.04		[a]1.28		98.36
Do	Lumpy layer	do	52.07	42.18				1.78		[a]4.00		100.03
Do	Chicago Union Lime Works Co.	J. Blodget Britton, Warrenton, Va.	52.76	45.04				1.48		[a].21	H_2O and loss, 0.51 per cent.	100.00
Do	do	do	54.21	44.65				.66		[a].12	H_2O and loss, 0.36 per cent.	100.00
Do	Stearns Lime & Stone Co.	T. C. Hopkins, State College, Pa.	52.75	44.28				.55		[a].60		98.18
ary	Dolese & Shepard Co.	Chemist, Illinois Steel Co.	53.09	43.82				1.96		1.42		100.29
Do	do	do			31.20	20.46	46.575		.43	.94	Fe, 0.36 per cent; P, 0.004 per cent; S, 0.031 per cent.	100.00
Hawthorne	do	do			30.74	22.61	44.54	.35	.67	1.05	SO_3, 0.036 per cent; P_2O_5, 0.004 per cent.	100.00

[a] Insoluble in acid.

[b] By ignition.

[c] Calculated.

Analyses of limestone quarried in the United States, by States—Continued.

Location.	Operator or owner.	Authority.	Calcium carbonate ($CaCO_3$).	Magnesium carbonate ($MgCO_3$).	Calcium oxide (CaO).	Magnesium oxide (MgO).	Carbon dioxide (CO_2)	Ferric oxide (Fe_2O_3).	Aluminum oxide (Al_2O_3).	Silica (SiO_2).	Other minerals.	Total.
ILLINOIS—continued.												
Cook County—Contd.			*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*		*Per ct.*
McCook	United States Crushed Stone Co.	Laboratory, Inland Steel Co.	55.30	43.95				0.26		0.36		99.81
Do	do	do	55.12	44.27				.36		.30		100.05
Do	do	do	55.30	43.95				.30		.28		99.83
Do	do	do	55.30	43.86				.34		.25		99.75
Do	do	do	55.65	43.61				.30		.26		99.82
Do	do	do	55.61	43.95				.36		.24		100.16
Summit	do	Chemist, Illinois Steel Co.			30.22	19.70	45.744	.36	1.33	2.58	SO_3, 0.059 per cent; P_2O_5, 0.007 per cent.	100.00
Thornton	Brownell Improvement Co.	Dickman & Mackenzie.	52.44	43.66				.85		2.35	Organic matter, 0.60 per cent.	99.90
Do	do	do	52.67	43.57				.85		2.10	Organic matter, 0.72 per cent.	99.91
Hancock County:												
Nioba	Fort Madison & Appanoose Stone Co.	J. C. Cary	53.93	36.59				2.65		4.69 a1.61	H_2O and loss, 0.21 per cent.	99.68
Jersey County:												
Grafton	Grafton Quarry Co.	Illinois Geological Survey.	47.79	42.86				1.40		a5.60	H_2O and loss, 2.35 per cent.	100.00
Kankakee County:												
Kankakee	Kankakee Quarries Co.	Chemist, Illinois Steel Co.			30.45	20.50	b43.544	2.50		3.00	P, 0.006 per cent.	100.00
Do	Lehigh Stone Co.	Pittsburgh Testing Laboratory, Pittsburgh, Pa.	46.18	35.05				1.19	4.28	10.78	H_2O and loss, 2.50 per cent; P, 0.02 per cent; S, trace.	100.00
Do	do	Robt. W. Hunt & Co.	50.80	40.40					3.00	5.50	H_2O and P, 0.30 per cent.	100.00
Do	do	do	47.73	35.86				1.12	4.35	10.30		99.36
Do	do	do	51.07	40.62				1.64	1.48	5.00		99.81
Madison County:												
Alton	Alton Lime & Cement Co.	H. E. Tuttle, St. Louis, Mo.	97.53	.44				.16		.48	H_2O and loss, 1.48 per cent.	100.09
Alton (top layer)	Harry Gissal Quarry Co.	R. W. Erwin, Granite City, Ill.	98.20	Trace.				Trace.		.30		98.50
Alton (No. 1)	do	do	92.35	1.00				Trace.		6.52		99.87
Alton (No. 2)	do	do	95.98	.75				Trace.		2.41		99.14
Alton (No. 5)	do	do	97.30	.21				Trace.		1.00		98.51
Alton (north layer)	do	do	97.81	1.35				Trace.		1.00		100.16
Alton (south layer)	do	do	98.09	.94				Trace.		.50		99.53

Alton (building stone).	....do	....do	95.53	.14	......	......	......	.16	......	.48	H$_2$O and loss, 0.14 per cent.	96.45
Alton	Reliance Quarry & Cons. Co.	E. L. Ohnsorg	95.79	.38	......	......	......	.41	1.41	2.01	......	100.00
Do	....do	......	......	......	53.11	2.00	[c]43.30	.68		.30	......	99.39
Monroe County:												
Millstadt	Columbia Quarry Co	......	98.43	......	......	.01	......	.44	......	1.12	......	100.00
Mount Carroll County:												
Mount Carroll	G. E. Hungerford	......	54.06	43.68	......	......	......	1.12		1.62	......	100.48
Rock Island County:												
Moline	Cady Stone Co	......	79.34	1.93	......	......	......	7.43		11.00	......	99.70
Do	....do	......	98.04	.44	......	......	......	.66		1.46	......	100.60
Do	Moline Stone Co	F. A. Genth, Philadelphia, Pa.	......	......	54.44	.056	42.023	[d] .348	......	.65	H$_2$O, 0.556 per cent; P$_2$O$_5$, 0.083 per cent; SO$_3$, 1.806 per cent; organic matter, trace.	99.962
St. Clair County:												
Columbia	Columbia Quarry Co	Pittsburgh Reduction Co., Pittsburgh, Pa.	97.30	.48	......	......	......	1.40		.90	......	100.08
Union County:												
Anna	Fruit Growers Refining & Power Co.	R. W. Hunt & Co., Chicago.	......	......	52.15	1.37	[c]43.62	.66		1.98	......	99.78
Winnebago County:												
Rockton	Rockton Lime & Quarry Co.	......	51.03	33.31	......	......	......	......	3.29	3.14	CO$_2$ and H$_2$O, 6.28 per cent; Fe, 1.25 per cent; S, 1.26 per cent.	99.56
Do	....do	E. C. Eckel	51.33	37.33	......	......	1.93	.79	1.05	6.39	H$_2$O, 1.01 per cent	99.83
Do	....do	E. G. Smith, Beloit College, Wis.	......	......	29.72	21.74	46.42	.44		1.96	......	100.28
Do	....do	....do	......	......	30.71	21.78	44.90	.46		2.31	......	100.16
Do	....do	....do	......	......	28.82	20.04	46.77	.56		3.90	......	100.09
Do	....do	....do	47.77	40.95	......	......	......	1.73		9.08	......	99.53
INDIANA.												
Blackford County:												
Montpelier (top rock).	Baltes Stone Co	S. S. Gorby, State geologist.	......	......	42.92	3.88	41.20	4.70		2.75	H$_2$O, 0.95 per cent; loss and undetermined, 2.81 per cent; SO$_3$, 0.79 per cent.	100.00
Montpelier (intermediate rock).	....do	....do	......	......	42.55	4.40	39.10	5.25		2.68	H$_2$O, 1.25 per cent; loss and undetermined, 3.68 per cent; SO$_3$, 1.09 per cent.	100.00
Montpelier (bottom rock).	....do	....do	......	......	43.01	4.18	41.55	5.17		2.43	H$_2$O, 1 per cent; loss and undetermined, 1.78 per cent; SO$_3$, 0.88 per cent.	100.00

[a] Insoluble in acid.

[b] CO$_2$, loss, and undetermined.

[c] Loss on ignition.

[d] Given as ferrous oxide, FeO.

Analyses of limestone quarried in the United States, by States—Continued.

Location.	Operator or owner.	Authority.	Calcium carbonate ($CaCO_3$).	Magnesium carbonate ($MgCO_3$).	Calcium oxide (CaO).	Magnesium oxide (MgO).	Carbon dioxide (CO_2).	Ferric oxide (Fe_2O_3).	Aluminum oxide (Al_2O_3).	Silica (SiO_2).	Other minerals.	Total.
INDIANA—continued.												
Cass County:			*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*		*Per ct.*
Kenneth	Casparis Stone Co	S. S. Gorby, State geologist.	93.48			1.16		2.07		1.33	H_2O, 1.57 per cent; loss and undetermined, 0.39 per cent.	100.00
Crawford County:												
Marengo	Marengo Stone Co	F. H. Borradville, Ann Arbor, Mich.	97.28		0.47	.41			0.42	.37	Loss and undetermined, 0.37 per cent.	99.32
Harrison County:												
Milltown	Eichel Lime & Stone Co.	W. S. Blatchley, State geologist.	98.91	0.63				.15		*a*.48		100.17
Do	do	do	95.58	1.74				.14	.40	2.05		99.91
Huntington County:												
Huntington	Ohio & Western Lime Co.	G. M. Levette, Indianapolis.			42.92	4.41	41.20	4.70		2.75	H_2O, 0.95 per cent; loss and undetermined, 1.82 per cent; SO_3, 1.25 per cent.	100.00
Do	do	E. T. Cox, State geologist.			31.92	9.58	49.52	8.25		.50	H_2O, 0.50 per cent; SO_3, 0.54 per cent.	100.81
Jay County:												
Portland	A. & C. Stone & Lime Co.	Laboratory University of Michigan.			30.45	21.93	47.73	.10		.07	MnO, trace; SO_3, trace.	100.28
Lawrence County:												
Bedford	Indiana Bedford Stone Co.	Rose Polytechnic Institute.	98.27	.84				.15		*a*.64		99.90
Bedford (blue)	Indiana Quarries Co	Laboratory U. S. Geological Survey.	97.26	.37				.49		1.69	H_2O and loss, 0.19 per cent.	100.00
Bedford (buff)	do	do	98.20	.39				.39		.63		99.61
Bedford	United States Cement Co.	Case School of Applied Sciences, Cleveland, Ohio.			54.48	.36	43.40	.12	.38	.89	FeO, 0.13 per cent	99.76
Do	do	do			54.68	.32	43.44	.13	.34	.87		99.78
Bedford (pulverized waste).	Jno. Laughlin	American Window Glass Co.	98.54	.58				43		.63		100.18
Do	do	do	98.57	.29				.60		.54		100.00
Mitchell (pulverized waste).	Mitchell Lime Co	Dow Chemical Co., Cleveland, Ohio.	96.35	1.32				.30		1.86		99.83
Mitchell	do	do	97.04	.90				.34		1.08		99.36
Do	do	do	97.51	1.30				.10		.94		99.85
Williams	Bedford-Linton Crushed	S. W. Smith, Indian-	98.40			Trace.		.30	.10	1.20		100.00

Monroe County:												
Bloomington	Winter Bros. Stone Co.	Rose Polytechnic Institute.	98.11	.92				.16		[b].86		100.05
Clear Creek	Acme Bedford Stone Co.	do	97.39	.78				.13		[b].84	Alkalies, 0.10 per cent.	99.24
Ellettsville	Perry Stone Co.	Laboratory Illinois Steel Co., Chicago, Ill.	96.84	1.05				.42	.54	1.20		100.05
Owen County:												
Romona	Romona Oolitic Stone Co.	Rose Polytenchic Institute.			54.82	.31	43.49	.18		[b]1.26		100.06
Putnam County:												
Cloverdale	Hendrix Bros	S. D. Conner	98.87							[b]1.00		99.87
Green Castle	A. & C. Stone & Lime Co.		98.66			.13		.51		.66		99.96
Randolph County:												
Farmland	Maxville Stone Co	W. S. Blatchley, State geologist.			54.97	.46	43.68	.15		[b].76		100.02
Rush County:												
New Salem	D. W. Moore				31.05	20.53	[c]44.32	.25	.50	[b]3.04	SO_3, trace	99.69
Washington County:												
Campbellsburg	Lee L. Persise	Rose Polytechnic Institute.	55.71	42.20				.27	.05	.77		99.00
White County:												
Monon	Monon Crushed Stone Co.	Purdue University Lafayette.	56.28	43.26				.14		[b].33		100.01
IOWA.												
Benton County:												
Garrison	American Crushed Stone Co.	C. O. Bates, Cedar Rapids.	95.90	.75				2.00		1.10	H_2O, 0.15 per cent.	99.90
Madison County:												
Earlham	Iowa Portland Cement Co.				51.74	.50	[c]41.64	1.40		4.66		99.94
Do	do				45.72	1.00	[c]36.70	2.30		14.40		100.12
Do	do				48.20	1.62	[c]39.10	4.70		6.00		99,62
East Peru	Peru Stone & Cement Co.	C. N. Kinney, Des Moines.			52.42	.42	[c]43.91	.80		1.20	Na_2O and K_2O, 1.25 per cent.	100.00
Marshall County:												
Legrand	Legrand Quarry Co.	G. F. Kirby, Chicago, Ill.	74.10	23.35				1.20		.95	H_2O, 0.40 per cent.	100.00
Scott County:												
Bettendorf	Otto Thompson		96.17	3.21				.32		.10		99.80
Do	do		98.29	1.13				.36		.04		99.82
Do	do		51.04	27.26				7.84		13.50		99.64
Do	do		98.90	.61				.56		.08		100.15
Do	do		97.12		.58			.54		.25		98.49
Buffalo	Dolese Bros	Dearborn Drug & Chemical Co.	92.68	1.03				.80		3.74	H_2O and organic matter, 1.50 per cent; $CaSO_4$, trace; loss, 0.25 per cent.	100.00
Le Claire	Le Claire Stone Co.	Chicago Portland Cement Co.	98.72	.28				.36		.32		99.68
Winneshiek County:												
Decorah	Maurice Halloran	S. W. Beyer, Ames	88.97	2.86				1.00		[b]6.87		99.70

[a] Includes H_2O.

[b] Insoluble in acid.

[c] Loss on ignition.

Analyses of limestone quarried in the United States, by States—Continued.

Location.	Operator or owner.	Authority.	Calcium carbonate ($CaCO_3$).	Magnesium carbonate ($MgCO_3$).	Calcium oxide (CaO).	Magnesium oxide (MgO).	Carbon dioxide (CO_2).	Ferric oxide (Fe_2O_3)	Aluminum oxide (Al_2O_3).	Silica (SiO_2).	Other minerals.	Total.
KANSAS.												
Chase County:			*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*		*Per ct.*
Cottonwood Falls	E. D. Jones & Son	A. H. Bryan, Rocky Ford, Colo.	90.50	1.36				0.84		a 6.64	Undetermined, 0.66 per cent.	100.00
Do	Rettiger & Norton	Dr. S. W. Williston, Lawrence, Kans.	84.72	1.75				3.62		a 8.57	Sulphates, 0.90 per cent.	99.56
Elk County:												
Moline	Moline Lime, Stone & Cement Co.	E. H. Baily, University of Kansas.	93.10	.39				3.42		1.33	Undetermined, 1.76 per cent.	100.00
Do	do	do	94.84	.42				2.26		.95	Undetermined, 1.53 per cent.	100.00
Do	do	do	96.39	.51				1.76		.69	Undetermined, 0.67 per cent.	100.02
Do	do	do	95.70	1.02				.56		a 1.34	Undetermined, 1.38 per cent.	100.00
Greenwood County:												
Fall River		Geo. Steiger, U. S. Geological Survey.			51.98	0.06	41.13	0.50	1.55	2.56	H_2O, 1.36 per cent; FeO, 0.47 per cent.	99.61
Lyon County:												
Emporia	John E. Hinshaw	A. J. Smith, Emporia, Kans.	78.50	2.00				10.00		a 9.50		100.00
Marion County:												
Marion	Isaac C. Kuhn	Dr. S. W. Williston, Lawrence, Kans.	91.50	1.62				1.24		a 5.51		99.87
Do	do	do	51.05	40.51				1.59		a 6.75		99.90
Do	do	do	61.64	22.72				1.65		a 3.51		99.52
Wyandotte County:												
Kansas City	The Phelps Stone & Supply Co.	R. M. Bird, Columbia, Mo.	96.00	.18				.82		2.84		99.84
KENTUCKY.												
Carter County:												
Lawton	J. B. Collier		94.00								Clay and H_2O, 6 per cent.	100.00
Do	Chas. Oppenheimer		93.00							7.00		100.00
Limestone	Limestone Mining Co.	Chemist Hanging Rock Iron Co., Hanging Rock, Ohio.	94.51			.38		b 1.30		3.80	P, 0.007 per cent.	99.997
Meade County:												
Brandenburg	Kosmos Portland Cement Co.	Cornell University laboratory.	98.56			.31		c .36		.61		99.84

Pendleton County: Ivor	Ohio River Stone Co	H. Simonson, Cincinnati, Ohio.	92.00			1.15		1.70		3.56	Organic matter, 0.67 per cent.	99.08
Trigg County: Cerulean	Tri-State Stone Co	Laboratory University of Mississippi.	94.00			3.00			*c* 1.00	2.00		100.00
Warren County: Hadley	Caden Stone Co	Laboratory Purdue University.			54.80	Trace.	33.00	.22		.76	H_2O, 0.38 per cent; organic matter, 3.31 per cent; K_2O and Na_2O, 6.48 per cent; SO_3 and P_2O_5, trace.	98.95
Memphis Junction	Bowling Green White Stone Co. of Kentucky.		98.00									98.00
Do	do	U. S. Geological Survey laboratory.	95.31	1.12				.39		1.42	H_2O, 1.76 per cent	100.00
Do	do	do	95.16	1.20				.50		1.20	H_2O, 1.94 per cent	100.00
LOUISIANA.												
Winn Parish: Winfield	Southern Mineral & Land Improvement Co.	Adam Wirth			56.95	1.20	*e* 35.00	1.50		1.25	SO_3, 0.82 per cent	96.72
Do	do	Laboratory U. S. Geological Survey.			55.47	.30	43.63	.23	.04	.17	H_2O, 0.21 per cent	100.05
MAINE.												
Knox County: Rockland	Rockland Lime Co	F. C. Robinson, Bowdoin College.	83.40	10.40						5.40	$FeCO_3$ and Al_2O_3, 1.10 per cent.	100.30
Do	Rockland-Rockport Lime Co.	do			54.97	.04	43.25		.07	1.08	FeO, 0.08 per cent; organic matter, 0.28 cent.	99.77
Thomaston	Rockland (Snow Coburn quarry).	do	96.92	1.31				.25		1.66		100.14
Do	Rockland (J. O. Cushing & Co. quarry).	do	96.82	1.77				.35		1.28		100.22
Do	Rockland (Levensaler quarry).	do	74.36	21.62				1.04		1.85		98.87
Warren	McLoon & Stover Lime Co.	L. C. Sharpless, Boston, Mass.	53.52	45.13						.95	H_2O, 0.40 per cent	100.00
MARYLAND.												
Baltimore County: Cockeysville	M. B. Price		97.67	1.50					.25	.55		99.97
Carroll County: Westminster	James Staub	Chemist, Western Maryland College.			46.86	5.38	44.50	1.67		*d* 1.27		99.68
Do	do	do			50.99	.26	45.85	.47		*d* .86		98.43
Do	do	do			47.69	1.42	44.67	1.46		*d* 3.30		98.54
Do	do	do			83.42	.83	10.09	1.67		*d* 3.02		99.03

a Insoluble in acid. *b* Includes MnO. *c* Includes FeO. *d* Insoluble in acid. *e* Loss on ignition.

Analyses of limestone quarried in the United States, by States—Continued.

Location.	Operator or owner.	Authority.	Calcium carbonate (CaCO$_3$).	Magnesium carbonate (MgCO$_3$).	Calcium oxide (CaO).	Magnesium oxide (MgO).	Carbon dioxide (CO$_2$).	Ferric oxide (Fe$_2$O$_3$).	Aluminum oxide (Al$_2$O$_3$).	Silica (SiO$_2$).	Other minerals.	Total.
MARYLAND—contd.												
Frederick County:			*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*		*Per ct.*
Catoctin	A. M. Isanogle	Penniman & Browne	54.72	44.34						0.80		99.86
Frederick	M. J. Grove Lime Co. (dark).	Julian O. Hargrove, Washington, D. C.	97.32	2.03				0.25	0.29	.22		100.11
Do	M. J. Grove Lime Co. (light).	do	96.79	2.86				Trace.	.16	.10		99.91
Le Gore	Legore Combination Lime Co.	Delaware State chemist.	96.44	1.41				.25		2.70		100.80
Do	do	Maryland State chemist	98.39	.51				.60		.50		100.00
Walkersville	Fountain Rock Lime Co.	H. J. Patterson, College Park.	93.57	.30				1.40		4.73		100.00
Do	do	do	81.97	13.00				.90		4.31		100.18
Do	Frank McAleer	Penniman & Browne	84.01	5.88				.39	3.42	5.68	K$_2$O, 0.31 per cent; organic matter, 0.31 per cent.	100.00
Harford County:												
Cardiff	Cardiff-Cambria Marble Co.	F. J. Metzgar, New York, N. Y.			1.06	35.67		4.51	2.05	39.97	TiO$_2$, trace; FeO, 2.81 per cent; H$_2$O, 14.29 per cent.	100.36
Washington County:												
Cavetown	G. M. Bushey & Son	Lehman & Glaser, Baltimore.			55.51		a 44.02			.47		100.00
Pinesburg	Potomac Valley Stone & Lime Co.		98.81	.87				Trace.	.42	.40		100.50
Do	do		98.32	1.17				.40		.56		100.45
MASSACHUSETTS.												
Berkshire County:												
Ashley Falls	Ashley Falls Marble Co.	Ricketts & Banks, New York, N. Y.			30.03	21.37	47.42	.43	.07	.28	SO$_3$, 0.03 per cent; Na$_2$O, 0.16 per cent; K$_2$O, 0.04 per cent.	99.83
Cheshire	Cheshire Lime Manufacturing Co.	Davenport & Williams, Boston.	98.80	.37				.23		.31	Organic matter, 0.35 per cent.	100.06
Do	Farnam Cheshire Lime Co.	Lathburg & Spackman, Philadelphia, Pa.	98.96					.42		.61		99.99
Do	do	do	99.28					.08		.13		99.49
Do	do	do	99.46					.55		.15		100.16
Lee	Lee Marble Works	Jno. McArthur, jr	48.00	49.00					.32	1.08	H$_2$O and loss, 1.60 per cent.	100.00

		laer Polytechnic Institute										
Richmond	Richmond Lime Co	Department of Agriculture.			55.00	.30	42.34	.20		2.16		100.00
Sheffield	Berkshire Hills Co	Ricketts & Banks, New York, N. Y.	98.34	.50						.38	FeO, 0.14 per cent; H_2O, 0.64 per cent.	100.00
Do	Massachusetts Lime Co.	E. R. Squibb & Sons, New York, N. Y.			53.05	2.37	43.06	.05		1.05		99.58
West Stockbridge	C. H. Hastings	J. Blodget Britton, Warrenton, Va.	99.029	.266								99.295
Do	West Stockbridge Lime Co.		97.00	1.25				.60		1.00		99.85
Do	do		96.00	2.00						1.00	Undetermined, 1 per cent.	100.00
Zylonite	Hoosac Valley Lime Co.	C. F. McKenna			52.76	.18	[a] 41.14	.40		5.52		100.00
Do	do	Hartford Laboratory Co., Hartford, Conn.			54.20	.26	[a] 42.68	.80		2.06		100.00
Hampden County:												
Westfield	Westfield Marble & Sandstone Co.	Arthur A. Noyes, Massachusetts Institute of Technology.			32.77	19.68	46.91			.20	FeO, 0.41 per cent	99.97
MICHIGAN.												
Alpena County:												
Alpena	Alpena Portland Cement Co.	Company chemist	98.22	.98				.55		.32		100.07
Do	do	do	97.40	.75				.26		1.45		99.86
Do	R. Collins	Lake Superior Carbide Works, Sault Ste. Marie.	98.54	1.24				Trace.				99.78
Charlevoix County:												
Charlevoix	Standard Portland Cement Co.	Holland Sugar Co., Holland.	96.85	1.71				.59		.47	H_2O, 0.07 per cent; $CaSO_4$, 0.12 per cent; organic matter, 0.03 per cent; undetermined, 0.16 per cent.	100.00
Do	do	R. F. Wentz, Detroit	96.16	1.44					.04	.80		98.44
Cheboygan County:												
Afton	Campbell Stone Co	C. S. Lindford, Bay City.	98.80									98.80
Chippewa County:												
Rexton	Union Carbide Co	I. R. Edmonds			54.01	.36	[a] 44.33	.39		.91		100.00
Emmet County:												
Petoskey	Antrim Lime Co	Antrim Iron Co	97.79	1.17				.50		.67		100.13
Do	do		98.72	.39				.38		.36		99.85
Do	do		97.83	1.30				.42		.26		99.81
Do	do		99.08	Trace.				.38		.58		100.04
Do	do		95.87	1.15				1.06		1.98		100.06
Do	do		98.65	.86				.28		.16		99.95
Do	do		96.55	2.17				.88		.54		100.14

[a] Loss on ignition.

Analyses of limestone quarried in the United States, by States—Continued.

Location.	Operator or owner.	Authority.	Calcium carbonate ($CaCO_3$).	Magnesium carbonate ($MgCO_3$).	Calcium oxide (CaO).	Magnesium oxide (MgO).	Carbon dioxide (CO_2).	Ferric oxide (Fe_2O_3).	Aluminum oxide (Al_2O_3).	Silica (SiO_2).	Other minerals.	Total.
MICHIGAN—continued.												
Emmet County—Con.			*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*		*Per ct.*
Petoskey	Michigan Lime Co.	Strong & Dunham, Marquette.	87.65	11.22								98.87
Do	Petoskey Stone & Lime Co.	Prof. Kedzie, Lansing			53.96	0.46	40.44	0.76		0.36	H_2O, 0.08 per cent; organic matter, 3.94 per cent.	100.00
Do	do	do			53.86	.60	41.50	.88		.52	H_2O, 0.04 per cent; organic matter, 2.60 per cent.	100.00
Mackinac County:												
Fiborn Quarry	S. B. Martin Co.		96.70					.46		.57	Loss, 0.04 per cent; organic matter, 0.06 per cent; $CaSO_4$, 1.02 per cent.	98.85
Ozark	Ozark Stone Quarry	Lake Superior Co., Sault Ste. Marie.	53.70	42.68						a .56	FeO, 1.65 per cent.	98.59
Monroe County:												
Dundee	B. E. Bullock	Prof. Kirschmier, Toledo.	95.00	3.86					.41	.81		100.08
Monroe	Monroe Stone Co.	K. J. Sundstrom	54.54	42.75				.01		.70		98.00
Do	do	do	54.47	43.59				.22		.98		99.26
Do	do	do	54.94	42.84				.31		.58		98.67
Presque Isle County:												
Calcite	Michigan Limestone & Chemical Co.	H. H. Hindshaw	97.85	1.26						.34		99.45
Do	do	J. G. Deane	98.34	.62				.20		.45		99.61
Schoolcraft County:												
Manistique	White Marble Lime Co.		94.73	3.82				.26		.56		99.37
Wayne County:												
Gibraltar	Gibraltar Quarry Co.	Detroit Testing Laboratory.	58.44	40.50				.38		.58		99.90
River Rouge (Detroit).	Dunbar Stone Co.	Robt. W. Hunt & Co.	52.69	42.95				Trace.		1.88		97.52
Sibley	Solvay Process Co.	W. G. Smerling	95.31	2.75				.20		1.25		99.51
Do	do	do	95.20	2.32				.35		2.22		100.09
Trenton	do	H. Harrison	98.53	.53				.06		.60		99.72
Do	do	do	97.50	1.26				.08		.40		99.24
Do	do		98.00	1.00				.02		.80		99.82
Do	do		90.00	8.50				.03		1.20		99.73

MINNESOTA.												
Blue Earth County: Mankato	The Widell Co.	University of Minnesota.	48.26	38.67				0.96	4.51	7.35	TiO_2, 0.08 per cent; P_2O_5, 0.06 per cent.	99.89
Rice County: Faribault	J. M. St. George	Carver County Sugar Co.	94.09					.57		.86	$CaSO_4$, trace; organic matter, 0.84 per cent.	96.36
Washington County: Stillwater	C. H. Carli	W. Lehman, St. Paul	64.45	20.14				2.82	1.66	7.33	$CaSO_4$, 4.06 per cent.	100.46
MISSOURI.												
Caldwell County: Breckenridge	Breckenridge Stone Co.				54.22	.22	42.58	.54		[a] 2.93		100.49
Cape Girardeau County: Cape Girardeau	Cape Lime & Marble Co.	Lytton & Crawford, Fort Dodge, Iowa.	99.57						Trace.	Trace.		99.57
Do.	do.				55.73	.24	43.91	.14		[a] .10	H_2O, 0.27 per cent.	100.39
Jackson	W. W. Taylor & Son.				52.29	.97	41.72	.28		[a] 4.66		99.92
Greene County: Ash Grove	Ash Grove Lime & Portland Cement Co.	Chas. W. Eoff	99.82			Trace.		.01	.05	.12	Mn and S, trace; P, none.	100.00
Phenix	Phenix Stone & Lime Co.		99.06	.58				.23		[a] .21		100.08
Springfield	Horton Stone Co.		99.34	.22				.13		[a] .36		100.05
Do.	Marble Head Lime Co.	R. Chauvenet & Bro., St. Louis.	99.46					.21		.33		100.00
Wilson Creek	Rogers White Lime Co.				55.48	.025	43.70	.12		[a] .45	H_2O, 0.42 per cent.	100.195
Jackson County: Courtney	Temple Investment Co.	Kansas City Portland Cement Co.			43.28		[b] 35.86	5.20		12.40	P_2O_5, 2.59 per cent.	99.33
Independence	Kansas City Material Co.	Kansas City Testing Laboratory.			54.00	.40	[b] 41.25	.50	1.20	2.50	SO_3, trace	99.85
Do.	do.	do.			54.20	.10	[b] 41.90	.40	.70	2.60	do.	99.90
Leeds	Western Crushed Rock & Concrete Co.	do.			52.80	.55	[b] 41.00	.60	1.20	3.60	SO_3, trace; alkalies, trace.	99.75
Sugar Creek	National Brick & Stone Co.	Henry S. Spackman, Philadelphia, Pa.			47.94	3.65	[b] 42.09	1.34		3.63		98.65
Do.	do.	University of Kansas.	95.41	1.02				1.19		3.17		100.79
Do.	do.	Missouri State School of Mines.	96.45	1.46				.53		[a] 2.73		101.17
Do.	do.	Jean Robert Moechel.			52.44	.63	[b] 43.10	2.76		.48	SO_3, 0.49 per cent; undetermined, 0.10 per cent.	100.00
Jasper County: Carthage	Carthage Marble & White Lime Co.		98.57	.65				.21		[a] .69		100.12
Do.	Carthage Superior Marble & Limestone Co.		99.27	.60				.18		[a] .63		100.68
Do.	do.	Mallinckrodt Chemical Works, St. Louis.	97.51	.24					.44	1.43	$FeCO_3$, 0.36 per cent.	99.98

[a] Insoluble in acid.

[b] Loss by ignition.

Analyses of limestone quarried in the United States, by States—Continued.

Location.	Operator or owner.	Authority.	Calcium carbonate ($CaCO_3$)	Magnesium carbonate ($MgCO_3$).	Calcium oxide (CaO).	Magnesium oxide (MgO).	Carbon dioxide (CO_2).	Ferric oxide (Fe_2O_3).	Aluminum oxide (Al_2O_3).	Silica (SiO_2).	Other minerals.	Total.
MISSOURI—continued.												
Jasper County—Contd.			*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*		*Per ct.*
Carthage	Carthage Superior Marble & Limestone Co.	State geologist	99.27	0.60				0.18		a 0.63		100.68
Do	do	W. Köken, Columbia University.	98.90	.07				.30		a .72	H_2O, 0.03 per cent.	100.02
Sarcoxie	Marble Head Lime Co.	St. Louis Sampling & Testing Works.	98.34	Trace.				0.05	.88	a .42		99.69
Jefferson County:												
Desoto	A. L. Frech		48.18	39.99				.68		a 11.19		100.04
Glen Park	Glencoe Lime & Cement Co.	H. A. Hunicke, St. Louis.	97.16			0.46			1.74	a .36	Organic matter, 0.28 per cent.	100.00
Rush Tower	Rush Tower Limestone Co.	Regis Chauvenet & Co., St. Louis.	97.67	.81						1.20	FeO, 0.32 per cent.	100.00
Marion County:												
Hannibal	Hannibal Lime Co	do	98.80			.02		.40		.08		99.30
Do	do	Lehigh Portland Cement Co., Lehigh, Pa.	98.75	Trace.						.30		99.05
Do	do		98.87	.62				.14		a .26		99.89
Do	Star Lime Co	Regis Chauvenet & Bro., St. Louis.	99.64	.21						a .15		100.00
Miller County:												
Spring Garden	Spring Garden Marble & White Lime Co.	American Steel Foundries, East St. Louis, Ill.	98.77									98.77
Do	do	R. Chauvenet & Bro., St. Louis.	99.42									99.42
Monroe County:												
Paris	Leon Stone Co	H. H. Hartzell	96.06	1.02				.88		1.43		99.39
Pettis County:												
Sedalia	Rymer Bros		49.21	31.57				1.08		a 17.96		99.55
Pike County:												
Bowling Green	J. F. Butters & Sons		49.77	34.46				1.62		a 13.99		99.84
St. Charles County:												
Foristell	Frederick Schroeder	Washington University, St. Louis.			55.69	.25	b 43.75	Trace.		.59		100.28
St. Clair County:												
Osceola	Osceola Lime Co		98.59	.09				.17		a .99		99.84
Ste. Genevieve County:												
Mosher	Peerless White Lime Co.		99.42	.60				.24		.24		100.00
Ste. Genevieve	Cliffdale Lime Co		99.44							.46		99.90
			99.34							.66		100.00

Do	do		99.32							.68		100.00
Do	do		99.15							.75		99.90
Do	do		99.97							.03		100.00
Do	Western Lime Works	R. Chauvenet & Bro., St. Louis, Mo.	97.16	.46				1.74		a .36	Organic matter 0.28 per cent.	100.00
St. Louis County:												
Fort Bellefontaine	Union Sand & Material Co.	R. C. Carpenter	97.41	.52				.92		.46		99.31
Glencoe	Glencoe Lime & Cement Co.	St. Louis Sampling & Testing Works.	98.36			.26		.68		a .70		100.00
Glendale	Stolle Stone Co	State Bureau of Geology and Mines.	97.22	.87				.17		a 2.03		100.29
Do	do		96.09	.90				.27		2.36		99.62
MONTANA.												
Carbon County:												
Bowler		E. Kowalk, Billings	97.67					2.20				99.87
Do		do	98.43					1.25				99.68
Do		do	98.24					1.40				99.64
Bridger		do	98.96					.85				99.81
Cascade County:												
Albright	The Boston & Montana Co.				51.80	3.20	b 44.10		.20	a .80		100.10
Gallatin County:												
Saphington		E. Kowalk, Billings	98.60					.80				99.40
Do		do	96.03					3.35				99.38
Trident	Three Forks Portland Cement Co.	H. W. Andrews, company chemist.			46.98	1.38	b 38.69		3.30	8.00	FeO, 1.16 per cent	99.51
Do	do	do			40.59	1.46	b 33.42		5.37	16.54	FeO, 1.31 per cent	98.69
Jefferson County:												
Limespur	East Montana Smelting Co.	E. Kowalk, Billings	95.50	2.31				1.48				99.29
Do	do	do	94.45	3.46				1.86				99.77
Do	do	do	96.35	2.63				.96				99.94
Do	do	do	94.80	2.02				1.62				98.44
Do	do	do	93.35	3.78				1.89				99.02
Do	do	do	94.65	3.60				1.20				99.45
Do	do	do	95.30	2.59				1.78				99.67
Do	do	do	97.30	1.47				1.22				99.99
Do	do	do	96.35	2.77				.86				99.98
Do	do	do	95.85	2.60				1.06				99.51
Do	do	do	97.05	1.40				1.30				99.75
Lewis & Clark County:												
East Helena	American Smelting & Refining Co.	American Smelting Co., East Helena.			52.80	2.00	43.80			1.40		100.00
Do	do	E. Starz, Helena	88.25	5.70				.76	.16	1.45	Gold, silver, and zinc, trace.	96.32
Park County:												
Livingston		E. Kowalk, Billings	97.68					1.65				99.33
Do		do	96.32					3.40				99.72

[a] Insoluble in acid.

[b] Loss by ignition.

Analyses of limestone quarried in the United States, by States—Continued.

Location.	Operator or owner.	Authority.	Calcium carbonate ($CaCO_3$).	Magnesium carbonate ($MgCO_3$).	Calcium oxide (CaO).	Magnesium oxide (MgO).	Carbon dioxide (CO_2).	Ferric oxide (Fe_2O_3).	Aluminum oxide (Al_2O_3).	Silica (SiO_2).	Other minerals.	Total.
NEBRASKA.												
			Per ct.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*		*Per ct.*
Cass County: Weeping Water	The Commercial Land Co.	American Beet-Sugar Co., Norfolk.			53.80	0.23	43.05	0.80		1.60	H_2O, 0.15 per cent; undetermined, 0.37 per cent.	100.00
NEVADA.												
Lyon County: Dayton	Dayton Lime Co.	Thomas Price, San Francisco.			51.38	.59	41.03	2.15		4.39	H_2O, 0.46 per cent	100.00
Do	do	do			48.72	.86	39.14	3.85		7.22	H_2O, 0.21 per cent	100.00
Ormsby County; Carson City	Chas. Snyder	F. A. Merryman, Carson City, Nev.	98.30									98.30
Do	do	do			55.10	Trace.	*a* 43.50	.30		1.10		100.00
Do	Western States Structural Materials Co.	E. T. Krebs	98.60	Trace.				Trace.		.80		99.40
Do	do	do	96.30	Trace.				.50		2.00		98.80
Do	do	do	91.00	2.00				Trace.		5.50	FeO, 1 per cent	99.50
Do	do	do	87.40	Trace.				1.20		11.00		99.60
Do	do	do	83.50	1.50				2.50		9.00		96.50
NEW JERSEY.												
Hunterdon County: Annandale	Reed & Sammet		73.73	15.96				.93		*b* 6.30		96.92
Bloomsbury	Philip A. Hazlett	Thomas Iron Co., Easton.	56.41	31.59				1.97		1.82	P, 0.03 per cent	91.82
Vernay	California Limestone Co.		50.98	35.07				2.76	.44	*b* 7.78	Na_2O and K_2O, 1.53 per cent; H_2O, 1.44 per cent; P, 0.035 per cent.	100.00
Do	E. J. Neighbour	H. B. Weaver	52.450	43.250				1.340	.545	2.28	P, 0.035 per cent	99.90
Sussex County: Hamburg	Consolidated Lime, Iron & Clay Co.	Stevens Institute of Technology, Hoboken.	99.02	Trace.				Trace.		.98	Graphite, trace	100.00
McAfee	New Jersey Lime Co.	Ricketts & Banks, New York, N. Y.			54.42	.93	41.54			.97	FeO, 0.56 per cent; NaO, 0.86 per cent; K_2O, 0.23 per cent; SO_3, 0.02 per cent;	100.00

											graphite, 0.17 per cent; loss and undetermined, 0.30 per cent.	
Ogdensburg	Bigelow & Swain	Hudson Iron Co., Secanus.	95.73	2.53				.46		.51		99.23
Warren County:												
Belvidere	Pequest Co.		94.25	2.01				2.54		1.20		100.00
Buttzville	Edison Portland Cement Co.	H. E. Kiefer	94.00	2.50					3.50			100.00
NEW MEXICO.												
San Miguel County:												
East Las Vegas	The Canyon Lime Co.	I. W. Reed, Rocky Ford, Colo.	97.99	.91				.61		*b*.71		100.22
Otero County:												
Alamogordo	Frank Falcone		55.00			.31	44.00			.30	Fe, 0.30 per cent.	99.91
NEW YORK.												
Cayuga County:												
Auburn	International Harvester Co.		62.72	30.84				2.07		5.27		100.90
Dutchess County:												
Dover Plains	Dutchess Conuty Lime Co.	Ledoux & Co., New York.			30.42	21.66	46.34	.41	.23	.80		99.86
South Dover	South Dover Marble Co.	Ricketts & Banks, New York.			30.63	20.25	46.66	.25	.37	.70	Na_2O, 0.12; per cent; K_2O, 0.46 per cent; loss and undetermined, 0.56 per cent.	100.00
Wingdale	Dover White Marble Co.	E. F. Briggs			60.10	37.50					SiO_2, Al_2O_3, Fe_2O_3, Na_2O and K_2O, 2.40 per cent.	100.00
Greene County:												
Alsen	Alsen American Portland Cement Works.	Emil Mueller			46.07	.35	*a* 36.75	2.40	4.30	9.75	SO_3, 0.37 per cent	99.99
Do	do	do			38.63	.85	*a* 31.80	1.85	7.06	18.77	SO_3, 0.50 per cent	99.46
Jefferson County:												
Chaumont	Adams & Duford Co.	Chas. H. Stowell, Albany.	97.95	.88				.66		.21	S, 0.30 per cent	100.00
Livingston County:												
Caledonia	Caledonia Marl Co.	Edward J. Wheeler Albany.	97.39	.39				.13	1.07	.67	H_2O, 0.34 per cent	99.99
Madison County:												
Oneida	Jno. H. Mitchell	J. M. Bodt, jr., Syracuse			52.66	1.31	42.52	1.31		2.18	SO_3, 0.05 per cent	100.03
Monroe County:												
Honeoye Falls	Genesee Lime Co.	A. S. Crocker, Rochester.	94.67	2.46				.04		3.79		100.96

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a Loss by ignition.

b Insoluble in acid.

Analyses of limestone quarried in the United States, by States—Continued.

Location.	Operator or owner.	Authority.	Calcium carbonate ($CaCO_3$).	Magnesium carbonate ($MgCO_3$).	Calcium oxide (CaO).	Magnesium oxide (MgO).	Carbon dioxide (CO_2).	Ferric oxide (Fe_2O_3).	Aluminum oxide (Al_2O_3).	Silica (SiO_2).	Other minerals.	Total.
NEW YORK—contd.												
			Per ct.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*		*Per ct.*
Onondaga County: Onondaga	J. E. Britton	Solvay Process Co., Syracuse.	95.39	1.11				1.41		2.09		100.00
Do	do	do	96.75	1.34				0.80		1.19	Organic matter, 0.20 per cent.	100.28
Do	do	do	94.08	1.31				1.01		3.10	Organic matter, 0.34 per cent.	99.84
Do	do	do	93.25	1.52				2.42		2.37	Organic matter, 0.35 per cent.	99.91
Do	do	do	96.35	2.22				.50		.92	Organic matter, 0.32 per cent.	100.31
Do	do	do	94.45	2.62				.75		2.08	Organic matter, 0.30 per cent.	100.20
Split Rock	Solvay Process Co	Company chemist	92.13	2.56				1.14		3.04	H_2O, 0.20 per cent; $CaSO_4$, 0.93 per cent.	100.00
Orange County: Newburgh	Jno. J. E. Harrison	Cornell University	54.53	39.41				.26		3.96	H_2O, 1.50 per cent	99.66
St. Lawrence County: Bigelow	Charles Williams & Co.	Riordan Paper Mills, Ontario, Canada.	91.68	5.00				.78		*a* 2.62	$CaSO_4$, 0.20 per cent	100.28
Gouverneur	Northern New York Marble Co.	Solvay Process Co., Syracuse.			51.45	3.49	42.56	.79		1.58	SO_3, 083 per cent	100.70
Do	Jno. J. Sullivan	N. W. Steel Co., Randall, Maryland.			51.08	2.95	44.22	Trace.		1.55		99.80
Oswegatchie	F. W. Kelley	C. A. Booth	93.80	1.02								94.82
Washington County: Smiths Basin	Keenan Lime Co	Albany & Rensselaer Iron & Steel Co., Albany.			54.15	.39	42.95	.02	.08	.97	Organic matter, 0.06 per cent; P_2O_3, 0.01 per cent; H_2O, 1.47 per cent.	100.10
Westchester County: Ossining	Ossining Lime Co	Ledoux & Co., New York.			30.04	22.28	47.14	.23		*a* .20		99.89
NORTH CAROLINA.												
Henderson County: Asheville	Blue Ridge Lime Co	Pittsburgh Testing Laboratory.	87.58	8.45				.43	.99	1.10	$CaSO_4$, 0.02 per cent; organic matter, 1.21 per cent; $Ca(PO_4)_2$, 0.22 per cent.	100.00

OHIO.												
Allen County:												
Lima	The Goetschius Stone Co.	S. V. Peppel, Columbus, Ohio.	52.82	44.03	....	....	....	.18	.71	1.55	P_2O_5, 0.11 per cent; SO_3, 0.28 per cent.	99.68
Clark County:												
Cold Springs	Casparis Stone Co.	Ellis Lovejoy, Columbus, Ohio.	54.05	44.94	....	....	....	.23		*a* .49	....	99.71
Springfield	H. H. Moores Co.	do	54.08	45.69	....	....	....	.29		.31	....	100.37
Crawford County:												
Spore	Broken Sword Stone Co., Quarry Ledge No. 1.	W. B. Campbell, chemist, Bureau Construction and Repair, U. S. Navy, Newhall, Pa.	88.76	7.20	....	....	....	.72		*a* 2.80	$CaSO_4$, 0.22 per cent; $CaPO_4$, 0.20 per cent; H_2O, 0.07 per cent.	99.97
Do	Broken Sword Stone Co., Quarry Ledge No. 2.	do	81.43	15.04	....	....	....	.57		*a* 2.89	$CaSO_4$, trace; $CaPO_4$, 0.12 per cent; H_2O, 0.08 per cent.	100.13
Do	Broken Sword Stone Co., Quarry Ledge No. 3.	do	88.82	8.13	....	....	....	.87		*a* 1.84	$CaSO_4$, 0.22 per cent; $CaPO_4$, 0.12 per cent; H_2O, 0.10 per cent.	100.10
Do	Broken Sword Stone Co., Quarry Ledge No. 4.	do	89.75	6.20	....	....	....	.32		*a* 1.84	$CaSO_4$, 0.12 per cent; $CaPO_4$, 0.08 per cent; bituminous matter, 1.69 per cent.	100.00
Do	Broken Sword Stone Co., Quarry Ledge No. 5.	do	91.46	6.55	....	....	....	.17		*a* 1.66	$CaSO_4$, 0.14 per cent; $CaPO_4$, 0.05 per cent.	100.03
Do	Broken Sword Stone Co., Quarry Ledge No. 6.	do	90.22	8.10	....	....	....	.20		*a* 1.38	$CaSO_4$, 0.06 per cent; $CaPO_4$, 0.03 per cent; H_2O, 0.04 per cent.	100.03
Do	Broken Sword Stone Co., Quarry Ledge No. 7.	do	82.60	14.31	....	....	....	.22		*a* 2.56	$CaSO_4$, 0.09 per cent; $CaPO_4$, 0.07 per cent.	99.85
Do	Broken Sword Stone Co., Quarry Ledge No. 8.	do	84.73	12.71	....	....	....	.24		*a* 1.93	$CaSO_4$, 0.15 per cent; $CaPO_4$, 0.10 per cent; H_2O, 0.08 per cent.	99.94
Do	Broken Sword Stone Co., Quarry Ledge No. 9.	do	94.76	3.88	....	....	....	.16		*a* .67	$CaSO_4$, 0.32 per cent; $CaPO_4$, 0.02 per cent; H_2O, 0.04 per cent.	99.85
Do	Broken Sword Stone Co., Quarry Ledge No. 10.	do	85.54	12.91	....	....	....	.19		*a* 1.11	$CaSO_4$, 0.31 per cent; $CaPO_4$, 0.02 per cent; H_2O, 0.06 per cent.	100.14
Delaware County:												
Delaware	Scioto Lime & Stone Co.	Edward Orton, State geologist.	92.64	4.75	....	....	....	.28		1.30	....	98.97
Erie County:												
Kelleys Island	Kelley Island Lime & Transportation Co.	do	89.08	8.34	....	....	....	.35		1.51	....	99.28
Do	Swan, Donogh & Co.	Tonawanda Steel & Iron Co.	78.00	15.10	....	....	....	....	.64	.70	Volatile, 5.72 per cent.	100.16
Sugarridge	Ohio & Western Stone and Lime Co.	Edward Orton, State geologist.	55.23	43.12	....	....	....	.69		.84	....	99.88

a Insoluble in acid.

Analyses of limestone quarried in the United States, by States—Continued.

Location.	Operator or owner.	Authority.	Calcium carbonate ($CaCO_3$).	Magnesium carbonate ($MgCO_3$).	Calcium oxide (CaO).	Magnesium oxide (MgO).	Carbon dioxide (CO_2).	Ferric oxide (Fe_2O_3).	Aluminum oxide (Al_2O_3).	Silica (SiO_2).	Other minerals.	Total.
OHIO—continued.												
Franklin County:			*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*		*Per ct.*
Columbus	Casparis Stone Co	Cleveland Rolling Mills	93.21	4.70	....	....	....	1.71		....	....	99.62
Do	do	J. C. Dickson, Muncie, Ind.	94.80	1.21	....	....	....	.80		3.20	....	100.01
Marble Cliff	Franklin Stone Co	....	91.03	6.86	....	....	....	....	.58	1.40	H_2O, 0.10 per cent; Fe, 0.40 per cent; P, 0.05 per cent.	100.375
Green County:												
Cedarville	D. S. Ervin Co	....	53.95	44.62	....	....	....	.57		.58	....	99.72
Hancock County:												
Findlay	Hancock Stone Co	Edward Orton, State geologist.	55.70	44.20	....	....	....	0.01	.12	.47	....	100.50
Highland County:												
Lynchburg	Frank Sharp	Jeffreys Manufacturing Co., Columbus, Ohio.	93.82	3.50	....	....	....	1.06		2.30	....	100.68
Lawrence County:												
Campbell	Vernon Iron Co	C. W. Boynton, Wheeling, W. Va	....	....	53.36	0.38	41.59	.69	.39	1.73	Organic, 0.16 per cent; S, 0.13 per cent.	98.43
Do	do	Jno. F. Davis, Ironton, Ohio.	....	....	54.68	Trace.	*a*43.52	1.12		.84	....	100.16
Do	do	do	....	....	54.26	.10	*a*43.54	1.06		1.14	....	100.10
Do	do	C. E. Scott, Ironton, Ohio.	95.94	.06	....	....	....	1.46		1.48	....	98.94
Do	do	do	94.87	2.13	....	....	....	1.58		1.60	....	100.18
Culbertson	Estate of Jno. Bradshaw.	W. R. Maxey, Culbertson.	....	....	52.89	Trace.	43.2784	....	2.36	1.21	P, 0.036 per cent; S, 0.2256 per cent.	100.00
Pedro	The Halley Coal Co	Star Furnace Co., Jackson, Ohio.	95.76	.757	....	....	....	....	....	.86	Moisture, 0.21 per cent; P, 0.075 per cent; S, 0.015 per cent.	97.677
Ironton	Ironton Portland Cement Co.	C. D. Quick	....	....	52.25	.25	43.40	.95	1.35	1.60	....	99.80
Do	do	do	....	....	52.76	.62	42.91	1.03	.63	1.64	P_2O_5, 0.33 per cent	99.92
Steece	E. B. Willard & Co	do	....	....	52.73	.75	43.14	2.28		.92	....	99.82
Do	do	Jno. W. Griffith	94.00	....	....	....	2.10	2.75		....	P_2O_5, 0.04 per cent	98.89
Do	do	....	95.17	.36	....	....	....	1.16	.47	1.06	P_2O_5, 0.03 per cent	98.85
Superior	Superior Portland Cement Co.	Jno. Blank, Superior	96.66	.97	....	....	....	....	....	.77	Undetermined, 0.163 per cent.	100.03
White House	Whitehouse Stone Co	Toledo Furnace Co., Toledo, Ohio.	....	....	49.34	2.63	*a*46.0937	....	.42	1.5075	P, 0.008 per cent	100.00
Lucas County:												
Silica	Toledo Stone & Glass Sand Co.	....	57.28	42.00	....	....	....	....	.60	.30	....	100.18

Marion County:												
Marion	Ohio & Western Lime Co.	Cleveland Rolling Mills.	86.22	9.27				2.30		b2.86	P, 0.11 per cent	100.76
Mercer County:												
Celina	Jno. W. Karch	S. V. Peppel	54.80	43.10					.52	1.14		99.56
Miami County:												
Covington	J. W. Ruhl	J. D. Lisle	53.00	37.11				.67	.33	3.77	Organic, 0.73 per cent; MnO, 0.73 per cent.	96.34
Piqua	Casparis Stone Co		98.75	.73				.23	.13	.18	P, 0.007 per cent	100.027
Do	do	Geo. W. Rockwell, Lehigh Portland Cement Co., Allentown, Pa.	98.23	1.09				.32		b.28		99.92
Do	Ohio Marble Co	J. C. Dickson, Muncie, Ind.	90.28	9.09				.12		b.23	Trace; H_2O, trace	99.72
Do	do	S. V. Peppel	88.11	10.83				1.21		1.04		101.19
Do	Stone Product Co	Edward Orton, State geologist.	94.70	4.30				.10	.56	.34		100.00
Do	do		96.78	2.37						.24		99.39
Do	do		95.16	3.88						.82		99.86
Do	do		97.91	1.63						.16		99.70
Do	do		94.77	3.95						.16		98.88
Do	do		96.15	2.95						.34		99.44
Ottawa County:												
Clay Center	Kelly Island Lime & Transport Co.	W. J. Rattle & Son, Cleveland.			38.56	13.78	45.172	.56		1.92	P, 0.008 per cent	100.00
Genoa	Ohio & Western Lime Co.	do	54.30	45.14				.16		b.23		99.83
Williston	Columbus Stone Co	G. A. Kirchmaier, Toledo.	53.90	44.82				.21		.21	P_2O_5, 0.001 per cent	99.141
Putnam County:												
Columbus Grove	Columbus Grove Stone Co.	Jeffrey Manufacturing Co., Columbus.	52.92	43.25				.75		2.76		99.68
Sandusky County:												
Bellevue	Bellevue Stone Co	J. E. Dickson, Muncie, Ind.	62.28	35.92				.40		1.20		99.80
Do	do	S. V. Peppel	56.30	37.91					.96	5.24		100.41
Do	do	do	56.10	34.59				.15	1.27	8.72		100.83
Do	do	do	63.15	27.97				.05	2.31	6.32		99.80
Do	do	American Sheet Steel Co., Muncie, Ind.	59.05	35.72				1.60		2.98		99.35
Do	do	do	62.28	35.92				.40		1.20		99.80
Do	do	do	57.44	39.63				.68		1.50		99.25
Do	do	do	59.72	36.38				.90		2.40		99.40
Gibsonburg	National Mortar and Supply Co.	Gulick & Henderson Co., Pittsburgh, Pa.	57.74	41.58				.22	.41	.16		100.11
Woodville	Woodville Lime & Cement Co.	J. C. Dickson, Muncie, Ind.	54.12	44.79				.25		b.29		99.45

a Loss on ignition.

b Insoluble in acid.

Analyses of limestone quarried in the United States, by States.—Continued.

Location.	Operator or owner.	Authority.	Calcium carbonate ($CaCO_3$).	Magnesium carbonate ($MgCO_3$).	Calcium oxide (CaO).	Magnesium oxide (MgO).	Carbon dioxide (CO_2).	Ferric oxide (Fe_2O_3).	Aluminum oxide (Al_2O_3).	Silica (SiO_2).	Other minerals.	Total.
OHIO—continued.												
			Per ct.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*		*Per ct.*
Scioto County:												
Eifort	Morgan & Horton	Burgess Steel & Iron Works, Portsmouth, Ohio.	97.32	0.45				1.40		.60		99.77
Seneca County:												
Fostoria	Ohio & Western Lime Co.	Wuth & Stafford, Pittsburgh, Pa.	57.45	40.80				0.07	.10	.32	H_2O, 1.26 per cent	100.00
Do	do	Edw. Orton, State geologist.	56.41	41.98				.28		*a* .42		99.09
Do	do	do	54.46	44.35				.34		.37		99.52
Do	do	Dr. Otto Wuth, Pittsburgh, Pa.	57.44	40.39				.04	.10	1.62	H_2O, 0.41 per cent	100.00
Stark County:												
Howenstine	Canton Lime & Fertilizer Co.	E. A. Oldham	91.16	1.63				1.20	1.86	4.12		99.97
Van Wert County:												
Van Wert	Erie Stone Co		53.03	45.02				.92		.97	P, 0.008 per cent; S, 0.023 per cent.	99.971
Do	The France Co		54.28	43.89				.94		.84	P, trace; S, 0.028 per cent.	99.978
Wood County:												
Luckey	Doherty & Co	Hugo Blanck, Pittsburgh.	57.30	36.70					.02	4.95	H_2O, 0.21 per cent; organic, 0.32 per cent.	99.50
Bowling Green	Ohio & Western Stone & Lime Co.	Edw. Orton, State geologist.	53.88	44.91				.40		*a* .30		99.49
Do	Wood County Stone & Construction Co.	G. A. Kirchmaier, Toledo.	53.00	45.00							All other, 2 per cent	100.00
Luckey	Ohio & Western Stone & Lime Co.	do	54.10	44.90				.36		.45		99.81
Stonyridge	Stony Ridge Stone Co		54.20	44.80				.52		.46		99.98
Do	do	H. W. Hess	53.46	43.54				1.83		*a* .91		99.74
Wyandot County:												
Carey	National Lime & Stone Co.	Metallurgical Laboratory, Pittsburgh, Pa.	54.00	45.27				.45		.10	P, 0.002 per cent	99.822
OKLAHOMA.												
Atoka County:												
Caddo	Caddo Lime Co	State geological survey	99.29									99.29

Reynolds	Oklahoma Oolite Stone Co.	University of Oklahoma.	96.98					.30	.10	2.60		99.98
Pittsburg County:												
Hartshorne	Choctaw Portland Cement Co.	do			55.20	.40	*b* 43.14	.26		*a* 1.10		100.10
Do	do	do			53.80	1.50	*b* 43.14	.10		*a* .90		99.44
Do	do	do			53.10	.70	*b* 44.34	.12		*a* 1.70		99.96
Do	do				53.53	.75	*b* 42.92	.18		2.62		100.00
Do	do	Kansas City Testing Laboratory.			54.70	1.10	*b* 42.10	.10	.60	1.10	SO_3, trace	99.70
Pontotoc County:												
Ada (Oolite Sta.)	do	Company chemist			55.08	.28	*b* 43.11	.10	.71	.42	PbO, 0.32 per cent	100.02
Fitzhugh	Oklahoma Oolite Stone Co.	University of Oklahoma.	97.12	1.26				.87			H_2O, 0.59 per cent	99.84
Sequoyah County:												
Marble City	Western Marble Co	Watertown Arsenal, Mass.	91.74	7.46				.60			$CaSO_4$, 0.20 per cent	100.00
Washington County:												
Dewey	Dewey Portland Cement Co.		81.20					3.20	3.40	8.50	H_2O and organic matter, 2.10 per cent; S, 0.25 per cent; alkali, 1.35 per cent.	100.00
Do	do	P. R. Chamberlain			44.24	1.23	*b* 36.29	6.45		11.92		100.13
Do	do	do			54.65	Trace.	*b* 43.29	.92		1.40		100.26
OREGON.												
Baker County:												
Pleasant Valley	Portland Lime & Lumber Co.	E. A. Akerly	97.13	.28				1.58		.40	Organic matter, 0.03 per cent; H_2O, trace; undetermined, 0.58 per cent.	100.00
Josephine County:												
Grants Pass	Range River Lime Co.	H. N. Laurie, Portland.	99.30	.20						*a* .20		99.70
Do	do	do	98.60	.80						*a* .40		99.80
PENNSYLVANIA.												
Adams County:												
Hanover	John R. Bittinger	Dr. Franklin Menges, York, Pa.	83.12	8.23				.03		.53 *a* 3.20	P_2O_5, 0.10 per cent; K_2CO_3, 4.23 per cent.	99.44
Do	do	C. A. Browne, State College, Pa.	95.36							*a* 1.03	K_2O, 0.36 per cent	96.75
Do	do	do	98.62							*a* .26	K_2O, 0.16 per cent	99.04
Do	Steacy & Wilton	Lackawanna Steel Co.	99.74	.40				.08		.06		100.28

a Insoluble in acid.

b Loss on ignition.

Analyses of limestone quarried in the United States, by States—Continued.

Location.	Operator or owner.	Authority.	Calcium carbonate ($CaCO_3$).	Magnesium carbonate ($MgCO_3$).	Calcium oxide (CaO).	Magnesium oxide (MgO).	Carbon dioxide (CO_2).	Ferric oxide (Fe_2O_3).	Aluminum oxide (Al_2O_3).	Silica (SiO_2).	Other minerals.	Total.
PENNSYLVANIA—cont.												
Armstrong County:			*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*		*Per ct.*
Apollo	Apollo Lime & Ballast Co.	Booth, Garrett & Blair.			53.27	.70	[a]42.15	2.75		1.75		100.62
Do	do	do			53.58	.26	[a]43.11	1.95	0.42	.73		100.05
Do	do	do			52.17	.64	[a]42.40	1.41	.25	2.93		99.80
Bedford County:												
Woodbury	J. R. Stayer		56.39	31.97				2.06		[b] 6.78	Undetermined, 0.80 per cent.	98.00
Berks County:												
Blandon	John Reeser		91.53	2.39					1.86	4.03		99.81
Kutztown	Sell D. Kutz	W. H. Boyer	89.54	3.02				1.55		3.99		98.01
Do	do		88.00	6.00						4.00		98.00
Do	do		90.00	4.00						3.00		97.00
Mertztown	J. L. Trexler		92.781	2.219		1.05			1.80	3.20		101.05
Morgantown	David M. Hertzler	Laboratory State College.	54.64	44.65				.74		[c] .35		100.38
Temple	Reading Quarry Co		55.50	43.00				1.10		.40		100.00
Blair County:												
Franklin Forge	St. Clair Limestone Co.				51.00	2.40	41.043		1.10	4.20	Fe, 0.25 per cent; P, 0.007 per cent.	100.00
Do	do	Company chemist	94.00	3.00						2.00		99.00
Frankstown	American Lime & Stone Co.	Schoenberger Steel Co.			54.90		[a]43.80	1.00		1.06		100.76
Martinsburg	Isaac Campbell		91.08	3.99				.86		3.07 [b] .95	Moisture, 0.10 per cent.	100.05
Butler County:												
Newcastle	Newcastle Portland Cement Co.	Carnegie Steel Co., Rankin, Pa.	51.00	.72			41.214	.90	1.62	3.50	H_2O, 1 per cent; P, 0.046 per cent.	100.00
Rough Run	T. K. Morris	Pennsylvania Salt Manufacturing Co., Natrona, Pa.	95.67	1.74				2.57			P, 0.031 per cent	100.011
West Winfield	do	do	95.10	1.12				1.00		[b] 2.78		100.00
Wick	Climax Lime & Stone Co.	—— Belcher, London, England.	96.20	1.25				1.77		[b] .78		100.00
Do	do	Geo. Hardy, Carnegie, Pa.	93.70	.50				1.40		[b] 3.70		99.30
Center County:												
Bellefonte	American Lime & Stone Co.	Dr. Otto Wuth, Pittsburgh, Pa.	98.50	.37					.19	.79	$FeCO_3$, 0.15 per cent	100.00
Benore	**A. & N. Gray**	**State College Experiment Station.**	**90.72**	**2.42**							**Sand, clay, etc., 8.04 per cent.**	**101.18**

Pleasant Gap	White Rock Quarries	D. E. Washburn, chemist, Bellefonte Furnace Co., Bellefonte, Pa.	97.75	.23				Trace.	.70	1.32		100.00
Do	do		99.009	.341				.220		b 4.30		100.00
Chester County:												
Avondale	Frank Williamson & Co.	Booth, Garrett & Blair, Philadelphia.	94.27	1.56				.26		b 3.91		100.00
Do	do	Prof. Henry Trimble, Philadelphia.	93.31	1.85				.40		b 4.44		100.00
Do	Frank Williamson & Co. (whitestone).	Chemist, Wellman Iron & Steel Co., and Tidewater Steel Co.	97.50	.75				1.04		.84	S, 0.004 per cent; P, 0.0046 per cent.	100.1386
Do	Frank Williamson & Co. (bluestone).	do	84.07	11.14				1.26		3.50	S, 0.0041 per cent; P, 0.0080 per cent.	99.9821
Do	Frank Williamson & Co. (graystone).	do	73.48	15.59				3.58		7.14	S, 0.0041 per cent; P, 0.0084 per cent.	99.8025
Devault	Chas. Warner Co.	Rosengarten & Sons, Philadelphia.	53.59	42.71				.37		2.80	H_2O, 0.53 per cent	100.00
Do	do	Company chemist			56.64	38.56		1.16		1.68	Loss, 1.62 per cent	99.66
Do	do	do			57.12	38.04		.84		2.04	Loss, 0.92 per cent	99.86
Do	do	S. S. Voorhees	51.74	43.34				.64		b 1.74		97.46
Mill Lane Station	Knickerbocker Lime Co.		65.00	30.00								95.00
Columbia County:												
Bloomsburg	Mrs. D. J. Waller, jr	Booth, Garrett & Blair, Philadelphia.			52.79	.62	42.40	.53	1.14	2.53		100.01
Cumberland County:												
Bowmansdale	H. A. Miller		94.55						.571	8.21	Mn_3O_4, 0.234 per cent; Mn, 5.336 per cent, P, 0.047 per cent; S, 0.013 per cent.	108.961
Dauphin County:												
Annville (near)	Walter T. Bradley	G. G. Pond, State College.	95.10	3.96				1.23	.14	1.07	Organic matter, slight trace.	100.50
Harrisburg	Hoffman & Wilson	S. H. Bigelow	87.68	9.46				1.72		2.29		101.15
Do	do	A. S. McCreath, Harrisburg.	89.30	6.70				1.00		3.00		100.00
Hummelstown	Vulcanite Limestone Co.		95.00						.02	.03		95.05
Palmyra	Annville Stone Co		97.00	.98				.26		.45		98.69
Do	do	Lackawanna Steel & Iron Co.	99.44	Trace.						.27		99.71
Do	do	do	98.78	.68						.30		99.76
Do	do	do	99.22	Trace						.65		99.87
Do	do	do	99.37	Trace.						.31		99.68
Do	Palmyra Quarry Co		98.11	1.00				.35		.50		99.96
Steelton	Pennsylvania Steel Co	Company chemist	89.50	7.00					Trace.	3.50		100.00
Swatara	Walter T. Bradley	Hugh Burgess	98.77	.30				.17		.62		99.86
Do	do	do	98.85					.60		.55		100.00
Do	do	do	98.10					.12		.12		98.34

[a] Loss by ignition.

[b] Insoluble in acid.

[c] Sand and clay.

Analyses of limestone quarried in the United States, by States—Continued.

Location.	Operator or owner.	Authority.	Calcium carbonate ($CaCO_3$).	Magnesium carbonate ($MgCO_3$).	Calcium oxide (CaO).	Magnesium oxide (MgO).	Carbon dioxide (CO_2).	Ferric oxide (Fe_2O_3).	Aluminum oxide (Al_2O_3).	Silica (SiO_2).	Other minerals.	Total.
PENNSYLVANIA—cont.												
Lancaster County.			*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*		*Per ct.*
Rheems	High C Lime & Stone Co.	State chemist, Harrisburg.	97.95	0.98				0.11			Loss and undetermined 0.96 per cent.	100.00
Lawrence County:												
Lowellville (near)	Geo. W. Johnson Limestone Co.	R. Pollock	89.35					0.38	3.54	5.05	P, 0.16 per cent	98.48
Youngstown	Carbon Limestone Co.	S. W. McKeown	96.43	.40				1.60		1.50	P, 0.02 per cent; S, 0.08 per cent.	100.03
Lebanon County:												
Annville	Annville Stone & Lime Co.	A. S. McCreath, Harrisburg.	98.928	.573				.260		.180		99.941
Do	J. B. Millard & Son	D. R. Haight, Laboratory, Lebanon Furnaces.	98.55	.63				.41		.50		100.09
Do	do	do	97.11	1.07				.66		.83		99.67
Do	do	do	97.41	.96				.63		.87		99.87
Do	do	do	96.68	1.65				.64		.96		99.93
Do	do		95.68	2.79				.72		.87		100.06
Do	do	do	96.07	1.81				.82		1.15		99.85
Do	do	do	96.92	1.48				.65		.86		99.91
Do	do	A. S. McCreath, Harrisburg.	98.36	.91				.24		.39	P, 0.002 per cent	99.902
Do	Whitehall Cement Manufacturing Co.	H. S. Snyder, company chemist.	97.00	1.16				1.80				99.96
Labanon	Lackawanna Steel & Iron Co.	Company chemist			36.50	13.50	^{b}43.091		1.90	5.00	P, 0.009 per cent	100.00
Do	Elam Siegrist	E. A. Brooks, chemist, Colebrook Furnaces.	90.91	6.70				.60		1.86		100.07
Meyerstown	General Crushed Stone Co.	Company chemist			52.20	.80	^{b}45.30	.57	.21	.92		100.00
Do	do	do			52.02	.76	^{b}45.00	.44	.62	1.16		100.00
Do	do	do			52.63	1.35	^{b}44.18	.31	.71	.82		100.00
Do	do	do			53.31	.80	^{b}44.19	.58	.48	.64		100.00
Do	do		95.73	.75				.90		2.52		99.90
Palmyra	Walter T. Bradley	Hamlin & Morrison	98.44									98.44
West Myerstown (near).	Calcite Quarry Co		98.38	.61				.49		.51		99.99
Do	do	Allentown Iron Co	97.00							.87	P, 0.053 per cent	97.923
Lehigh County:												
Allentown	Geo. F. Erich	Thomas Iron Co., Easton, Pa.	54.43	42.75				1.60		2.00		100.78

Do	do	do	53.43	44.20				1.50		1.32		100.45
Do	Ziegenfuss, Heiberger & Co.		54.00	44.75						1.25		100.00
Do	do	Allentown Testing Laboratory.	53.71	44.69					.96		Other elements, 0.64 per cent.	100.00
Do	do	Lehigh Valley Testing Laboratory.	53.56	44.87						1.09		99.52
Catasauqua	Ferdinand Eberhart	H. J. Detwiler, Allentown, Pa.	57.34	27.91				5.65		2.16	P, 0.01 per cent	93.07
Do	do	do	55.16	38.58				7.41		1.85		103.00
Do	Daniel Milson	K. A. Knause	90.00	3.50				1.50		5.00	P, 0.007 per cent	100.007
East Allentown	Trexler Bros	H. J. Detwiler, Allentown, Pa.	55.89	27.16				9.74		1.49		94.28
Lime Port	Erwin G. Erney	Prof. Frear, Pennsylvania State College.	49.86	37.57				2.60			Clay, sand, etc., 10.18 per cent.	100.21
Macungie	J. D. Christman	H. B. Erdman, Macungie, Pa.	46.614	43.212				1.28		6.82		97.926
Trexlertown	Israel Stettler	H. R. Hartzell	86.50	1.21				2.30		7.22		97.23
Lycoming County:												
Chippewa	M. E. Reeder	State College, Pa	90.71	.84				.80		*a* 5.85	Undetermined, 1.80 per cent.	100.00
Do	do	do	95.36	.87				.53		*a* 2.34	Undetermined, 0.90 per cent.	100.00
Do	do	do	94.82	.50				.58		*a* 3.87	Undetermined, 0.23 per cent.	100.00
Montoursville	I. F. Kach	do	89.28							*a* 2.71	Loss and undetermined, 8.01 per cent.	100.00
Mifflin County:												
Milroy	National Limestone Co.	R. Kent, Burnham, Pa.	95.75	2.03				1.36		1.69	P, 0.002 per cent	100.832
Do	do	do	96.24	2.86				.61		.33	do	100.042
Monroe County:												
Kunkeltown	Amazon L. Shaffer	Atlas Cement Co., Siegfried, Pa.	85.02	2.27				4.80		7.90		99.99
Montgomery County:												
Bridgeport	Merion Lime & Stone Co.		55.00	45.00								100.00
Do	Chas Warner Co	Chas. I. Reader	55.70	41.97				.72		1.58		99.97
Conshohocken	O'Neil Stone Co	Booth, Garrett & Blair.	55.05	41.01						2.07	P_2O_5, 0.011 per cent	98.141
King of Prussia (blue).	Millard, Schweyer Co.	G. G. Pond State College.	98.157			.509			.167	.771	FeO, 0.542 per cent; P_2O_5, 0.048 per cent; organic carbonaceous matter, 1.32 per cent.	100.326
King of Prussia (dark blue).	do	do	97.711			.798			.163	.582	FeO, 0.511 per cent; P_2O_5, 0.053 per cent; organic carbonaceous matter, 5.91 per cent.	100.409

a Insoluble in acid.

b By difference.

Analyses of limestone quarried in the United States, by States—Continued.

Location.	Operator or owner.	Authority.	Calcium carbonate ($CaCO_3$).	Magnesium carbonate ($MgCO_3$).	Calcium oxide (CaO).	Magnesium oxide (MgO).	Carbon dioxide (CO_2).	Ferric oxide (Fe_2O_3).	Aluminum oxide (Al_2O_3).	Silica (SiO_2).	Other minerals.	Total.
PENNSYLVANIA—cont.												
Montgomery County—Continued.			*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*		*Per ct.*
Morristown	Merion Lime & Stone Co.	Geo. C. Whittam	55.45	43.97					0.30	0.20		99.92
Do	W. W. Potts		96.64	2.85						.51		100.00
Do	do		62.00	33.94						1.32		97.26
Do	do				34.71	16.16	*a* 47.81			1.32		100.00
Do	do		99.02	.48				0.23		.21	P, 0.006 per cent	99.94
Do	do		92.08	6.00				.57		.75	P, 0.011 per cent	100.011
Do	do		59.91	38.43				.64		.97	P, 0.004 per cent	99.954
Do	do		88.00	11.57				.18		.27		100.02
Do	do		84.84	14.17				.33		.64		99.98
Do	do		61.92	35.51				1.60		.97		100.00
Do	Rambo Lime Co	Booth, Garrett & Blair, Philadelphia.	53.49	45.76				0.45		*b*.20		99.90
Do	do	do	54.04	45.51				.20		*b*.25		100.00
Plymouth meeting	E. J. Lavino & Co	do	54.06	44.63								98.69
Do	do	do	54.10	44.53				.36	.44	.56		99.99
Northampton County:												
Chain Dam	Robert J. Clark	F. H. Knight	54.11	38.72					2.99	1.59		97.41
Easton	Easton Lime Co	Prof. P. W. Shimer, Lafayette College, Easton, Pa.			30.04	19.67	45.54	1.64		3.11		100.00
Redington	C. H. Ziegenfuss & Co.		93.01	4.11				.96		1.55	P, 0.009 per cent; S, 0.020 per cent.	99.659
Northumberland County:												
Elk Lick	Keystone Lime Co		86.625	6.152				1.825		*b*4.640	P, 0.023 per cent; S, 0.093 per cent.	99.358
Listie	Listie Manufacturing Co.	Chemist, Dewees Wood Co., McKeesport, Pa.	92.12	2.35				2.00		*b*3.53	P, 0.02 per cent	100.02
Union County:												
West Milton	Geo. P. Miller	Prof. Wm. G. Owens, Bricknell University.			54.39	.653	42.90	.445		*b*1.504	Moisture, 0.046 per cent.	99.938
Westmoreland County:												
Calumet	Penn Lime Products Co.	H. C. Deming, chemist Pennsylvania State Highway Department.	82.14	9.12				.80	2.72	5.00	P_2O_5, 0.09 percent; Na_2O, 0.21 per cent; K_2O, 0.14 per cent; S, 0.11 per cent.	100.33
Herminie	West Westmoreland Stone & Lime Co.		94.205	2.16				1.33		2.03		99.725
Do	do	Wuth & Stafford, Pittsburgh.	93.21	1.40				.04	1.66	2.92	Organic, 0.10 per cent; $FeCO_3$, 0.67 per cent; P_2O_5, 0.007 per ceht.	100.007

York County:												
Dillsburg	Delaware Products Co.		76.00	5.00				16.00				97.00
Emigsville	Emigsville Quarry Co.	C. H. Ehrenfeld, York, Pa.	98.35	1.41				.13		.19	Organic, trace	100.08
Do	do	C. A. Jacobson, York, Pa.	96.35	2.08				.15	c .16	1.13	d P_2O_5, 0.05 per cent	99.92
Hellam	Steacey & Wilton Co.	A. S. McCreath, Harrisburg, Pa.	93.14	6.50				.14		.12		99.90
Thomasville	Thomasville Stone & Lime Co.	W. E. Mumford, Webster, Mass.	98.79	.82				.18		.21		100.00
Do	do	Franklin Menges, York, Pa.	99.08	.34				.08		b .47		99.97
Wrightsville	B. Frank Beard (white)	Prof. McDowell, State College, Pa.	95.29			.92				b .43		96.64
Do	B. Frank Beard (gray)	do	97.10			.64				b .32		98.06
Do	B. Frank Beard (white)	H. J. Patterson, College Park, Md.	94.53	3.18					1.80	b .49		100.00
Do	B. Frank Beard (gray)	do	93.32	3.32					3.10	b .26		100.00
Do	Steacey & Wilton Co.	A. S. McCreath, Harrisburg, Pa.	54.26	44.51				.66		.56		99.99
York	Palmer Lime & Cement Co.	E. R. Squibb & Sons, New York.			55.00	1.01	43.63	.38		.30		100.32
Do	do	do			56.12	.15	43.63	.19		.20		100.29
Do	York Valley Lime Co.	C. H. Ehrenfeld, York, Pa.	97.27	1.98				.17		.23	Organic, 0.09 per cent	99.74
Do	do	do	97.67	1.72				.16		.13	Organic, trace	99.68
RHODE ISLAND.												
Providence County:												
Lime Rock	Herbert Harris	Prof. J. H. Appleton, Brown University.	88.233	8.797				.011	.309	b 2.748	Moisture, 0.040 per cent.	100.138
SOUTH DAKOTA.												
Meade County:												
Doyle	W. V. Doyle	A. J. Clark, Lead, S. Dak., School of Mines, Rapid City, S. Dak.			53.63	.40	43.31	.28		b 1.82	SO_3, 0.005 per cent	99.445
Elk Creek	Herbert Clark				52.60	3.40	41.10					99.80
TENNESSEE.												
Campbell County:												
La Follette	La Follette Iron Co.	Company chemist			51.00	1.12	42.80		1.88	3.20		100.00
Carter County:												
Milligan	The Cranberry Furnace Co.		97.7963						.94	b 1.26	P, 0.0037 per cent	100.00
Do	do		97.7957						.80	b 1.40	P, 0.0043 per cent	100.00
Do	do	Jas. Eckman	53.50	45.08				.21	.16	b .98	P_2O_5, 0.0025 per cent; SO, 3.050 per cent.	99.9825
Claiborne County:												
Arthur	Virginia Iron, Coal & Coke Co.	Company chemist	95.00	2.40				1.10		1.38		99.88

[a] By difference.
[b] Insoluble in acid.
[c] As silicate feldspar.
[d] Calcium phosphate.

Analyses of limestone quarried in the United States, by States—Continued.

Location.	Operator or owner.	Authority.	Calcium carbonate ($CaCO_3$).	Magnesium carbonate ($MgCO_3$).	Calcium oxide (CaO).	Magnesium oxide (MgO).	Carbon dioxide (CO_2).	Ferric oxide (Fe_2O_3).	Aluminum oxide (Al_2O_3).	Silica (SiO_2).	Other minerals.	Total.
TENNESSEE—cont'd.												
			Per ct.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*		*Per ct.*
Coffee County: Summitville	Tennessee Cement & Lime Co.	J. M. Hurty, Indianapolis.	92.820	0.200				2.760		3.485	Organic and loss, 0.483 per cent; [b] H_2O, 0.252 per cent.	100.00
Davidson County: Mill Creek	Lightman Bros.	Prof. H. A. Morgan, University of Tennessee, Knoxville, Tenn.	97.64							[a]2.36		100.00
Franklin County: Sherwood	The Gager Lime & Manufacturing Co.	Company chemist			55.24	0.72	[c]42.06	.60		.60		99.22
Hamilton County: Daisy	Waterhouse Lime & Stone Co.	E. T. Leonard			54.28	.94	[d]43.90		.48	.40		100.00
Hickman County: Bon Aqua	J. H. Dean	Laboratory Standard Iron Co., company chemist.	95.14	2.16				.62		2.05	SO_3, 0.08 per cent; P_2O_5, 0.031 per cent.	100.081
Do	do	C. Maress, Goodrich, Tenn.	97.00									97.00
Jefferson County: Straw Plains	The Campbell & Deane Co.	Chemist, Jeffrey Manufacturing Co.	55.27	38.50				.58		5.38		99.73
Knox County: Knoxville	Tennessee Marble Lime Co.				55.320	.0216	43.510	.260	Trace.	.125	H_2O, 0.125 per cent; organic matter and loss, 0.6333 per cent; S, 0.0051 per cent.	100.00
Do	do		98.78			.0669						98.8469
Montgomery County: Clarksville	Red River Furnace Co.	W. E. Jones	93.535	1.903				.38		1.02	SO_3, 0.432 per cent; P_2O_5, 0.011 per cent; H_2O 2.719 per cent.	100.00
Do	do				54.08	.85	[d]43.30	.22	.38	[a]1.04	SO, 0.13 per cent	100.00
Rhea County: Graysville	Waterhouse Lime & Stone Co.				52.85	1.45	[d]43.48		.92	1.30		100.00
Sullivan County: Kingsport	Clinchfield Portland Cement Corporation.	S. Henry Harrison			54.87	.81	[c]43.04	.86		.58		100.16

TEXAS.												
Bexar County: Olga	Mission Lime Co	Northampton Portland Cement Co., Stockertown, Pa.	98.88	Trace.				.46		.46		99.80
Do	do	do	98.80	Trace.				.40		.48		99.68
Comal County: New Braunfels	Dittlinger Lime Co	P. S. Tilson, chemist, Houston Laboratories.	98.73	.77				.15		Trace.	Organic matter, trace; calcium sulphate, trace.	99.65
Do	do	H. S. Spackman Engineering Co., Philadelphia. Pa.	99.03									99.03
Coryell County: Oglesby	D. R. Boone	Prof. H. H. Harrington, Agricultural & Mechanical College & Experiment Station of Texas.			54.02	.12	43.96	.35		1.09	Organic matter, 0 52 per cent; SO_3, 0.17 per cent.	100.23
Dallas County: Cement	Texas Portland Cement Co.	M. P. Putman			50.92	.46	c42.10	.47	1.95	3.64		99.54
Do	do	A. A. Haskell			50.56		c41.16	4.06		3.74		99.52
Do	do	P. E. Howard			48.80		c41.50	3.40		4.60		98.30
UTAH.												
Morgan County: Devils Slide	Union Portland Cement Co.	Company chemist			46.62	2.45	39.05	.63	2.29	8.02		99.06
Do	do	do			26.63	2.57	26.06	3.45	7.97	31.96	SO_3, trace	98.64
Devils Slide (high rock).	do	F. H. Rouk			47.98	1.66	c39.57	4.00		6.20		99.41
Do	do	do			46.21	2.81	c39.51	4.04		7.18		99.75
Devils Slide (low rock).	do	do			29.23	2.41	c26.68	9.84	3.16	27.90		99.22
Do	do	do			30.47	3.12	c29.10	11 32		25.20		99.21
Devils Slide (straight rock).	do	do			41.87	3.00	c35.95	6.48		12.08		99.38
Salt Lake County: Mill Creek Canyon	Utah Lime & Cement Co				49.20	1.20	d47.10			2.50		100.00
Parleys Canyon	Union Lime & Stone Co.	R H. Officier & Co., Salt Lake City, Utah.	98.00	2.00								100.00
Salt Lake City	Langton Lime & Cement Co.	Crosman & Nichols			32.00	15.00	d52.00			1.00		100.00
Do	do	do			53.00		d44.00			3.00		100.00
Do	do	do			38.80	13.00	47.00			1.20		100.00
Do	do	do			53.00		44.40			2.60		100.00

[a] Insoluble in acid.

[b] Water and organic matter.

[c] Loss by ignition.

[d] By difference.

Analyses of limestone quarried in the United States, by States—Continued.

Location.	Operator or owner.	Authority.	Calcium carbonate ($CaCO_3$).	Magnesium carbonate ($MgCO_3$).	Calcium oxide (CaO).	Magnesium oxide (MgO).	Carbon dioxide (CO_2).	Ferric oxide (Fe_2O_3).	Aluminum oxide (Al_2O_3).	Silica (SiO_2).	Other minerals	Total.
UTAH—continued.												
Tooele County:			*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*		*Per ct.*
Tempie	T. R. & W. L. Ellerbeck.				53.28	Trace.	*a* 41.82	0.70	1.30	2.40	S, 0.50 per cent	100.00
Topliff	Utah-Idaho Sugar Co.		96.01	0.65				0.22		*b* 2.70	Moisture, 0.12 per cent; undetermined, 0.30 per cent.	100.00
Utah County:												
Lehi	Utah Sugar Co.	J. R. Hutchins, Lehi, Utah.	96.00	1.06				.15		.45	S, 0.12 per cent; moisture, 0.08 per cent; undetermined, 0.79 per cent.	98.65
Santaquin	W. Mont Ferry	R. H. Officior & Co., Salt Lake City, Utah.			54.00		*a* 43.00			3.00		100.00
VERMONT.												
Chittenden County:												
South Burlington	George B. Catlin	N. B. Smith, Sloss Iron & Steel Co.	99.20									99.20
Franklin County:												
Highgate Springs	L. H. Felton	S. P. Sharples, State assayer.			55.83	Trace.	43.65	.10		.40		99.98
Rutland County:												
Danby, Pittsford, Proctor, and West Rutland.	Vermont Marble Co.				54.76	0.16	43.21	.12	.92	.33	Organic matter 0.08 per cent; Na_2O and K_2O, 0.03 per cent; SO_3, 0.27 per cent.	99.88
Do	do		98.37	.77				.034	.005	.63	Organic matter, 0.08 per cent.	99.889
Danby, Pittsford, Proctor, and West Rutland (statuary marble).	do	Watertown Arsenal, Mass.			55.50	Trace.	43.65	.15		*b* .70		100.00
Danby, Pittsford, Proctor, and West Rutland (Sutherland Falls).	do	do			55.00	.25	44.08	.20		*b* .35		99.88
Danby, Pittsford, Proctor, and	do	do			55.27	.28	43.82	.30		*b* .28		99.95

West Rutland (extra dark blue).												
Danby, Pittsford, Proctor, and West Rutland (medium, dark, and light).	do	do			54.96	.29	44.09	.26		*b* .37		99.87
Danby, Pittsford, Proctor, and West Rutland (Rutland).	do	do			55.26	.15	43.65	.20		*b* .40		99.66
Windsor County:												
Amsden	Amsden Lime Co	W. W. Buch			38.94	11.32	42.74	1.43	1.35	3.33	MnO, 0.60 per cent; H_2O, .04 per cent; P, 0.087 per cent.	99.837
Do	do	do			50.00	1.66	40.09	.77	.37	5.98	MnO, 0.61 per cent; H_2O, 0.10 per cent; P, 0.065 per cent.	99.645
Do	do	do			52.78	1.60	42.74	.83	.42	.49	MnO, 0.84 per cent; H_2O, 0.085 per cent; P, 0.013 per cent.	99.798
VIRGINIA.												
Alleghany County:												
Longdale	Longdale Iron Co	S. R. Robinson	92.44	1.53				1.16		*b* 4.08		99.21
Do	do	W. L. Meaker	91.91	2.68				2.20		2.81		99.60
Do	do	F. C. Dillon	91.10	3.06				1.20		*b* 4.30		99.66
Botetourt County:												
Buchanan	Virginia Iron, Coal & Coke Co.	Company chemist	61.64	37.58				.52		.10		99.84
Do	do	do	53.90	42.59					.70	2.64		99.83
Do	do	do	54.30	43.80				1.29		.61		100.00
Cloverdale	H. H. Huggins				55.00		44.25			.75		100.00
Indian Rock	E. Dillon & Sons	Alleghany Ore & Iron Co.	99.11	Trace.				.32		*b* .28		99.71
Lithia	Roanoke Stone & Lime Co.	James H. Gibboney, Norfolk & Western Ry. Co.	97.85	Trace.				.88		*b* 1.04		99.77
Frederick County:												
Stephens City	M. J. Grove Lime Co	J. O. Hargrove, Washington, D. C.	97.33	.96				Trace.	.70	.57		99.56
Do	do	do	98.35	.86				Trace.	.43	.21		99.85
Do	do	do	93.00	4.00				Trace.	.90	1.75		99.65
Giles County:												
Ripplemead	New River Lime Co	Dr. Henry Froehling, Richmond, Va.	91.85	5.52				1.20		1.17	Organic, 0.25 per cent	99.99
Do	do	do	95.03	2.40				.25		2.12	Organic, 0.18 per cent	99.98
Do	do	do	96.04	1.75				.43		1.35	Organic, 0.40 per cent	99.97

[a] By difference.

[b] Insoluble in acid.

Analyses of limestone quarried in the United States, by States—Continued.

Location.	Operator or owner.	Authority.	Calcium carbonate ($CaCO_3$).	Magnesium carbonate ($MgCO_3$).	Calcium oxide (CaO).	Magnesium oxide (MgO).	Carbon dioxide (CO_2).	Ferric oxide (Fe_2O_3).	Aluminum oxide (Al_2O_3).	Silica (SiO_2).	Other minerals.	Total.
VIRGINIA—contd.												
			Per ct.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*		*Per ct.*
Montgomery County: Christiansburg	Alleghany Lime Co		98.40	1.07				0.17		[a]0.36		100.00
Rockbridge County: Natural Bridge	C. H. Paxton Rock Co		54.86	43.11				1.00		1.02		99.99
Russell County: Elk Garden	Stuart Land & Cattle Co.		97.70	.85				.24		1.20		99.99
Scott County: Gate City	Virginia Iron, Coal & Coke Co.	Company chemist	94.56	1.57				1.70		1.34		99.17
Shenandoah County: Strasburg	Powhatan Lime Co	Dr. Henry Froehling, Richmond.	99.01	.45				.08		.36		[b]99.90
Do	Shenandoah Lime Co	Virginia Iron, Coal & Coke Co.	98.57	.90				.53				100.00
Toms Brook	Rockdale Lime Co	C. Morris	97.30	1.25						.75		99.30
Woodstock	Woodstock Lime Co		97.10	1.15					1.05	[a].70		100.00
Wythe County: Barren Springs	Virginia Iron, Coal & Coke Co.	Company chemist	91.07	5.37				1.30		2.25		99.99
Patterson	Pulaski Iron Co	do	84.72	10.24				1.80		3.04	S, 0.15 per cent	99.95
WASHINGTON.												
Chelan County: Leavenworth	Alaska Marble Mountain Co.	Prof. C. R. Corey, University of Washington.	98.40	1.05				0.15	.03	.27	H_2O and undetermined, 0.10 per cent; S, trace.	100.00
Ferry County: Republic	Republic Gold Mines & Lime Works.	S. G. Dewsnap, Republic.	97.30	.41				.62		.66	Organic, 1 per cent	99.99
King County: Olga	Queen Brick & Lime Co.		96.34	1.18						1.32	FeO, 0.40 per cent	99.24
Lincoln County: Davenport	Pacific Coast Marble Co	Paul Baumle			53.70	43.40		1.40		2.50		101.00
San Juan County: Deer Harbor	Henry Cowell Lime & Cement Co.	H. Byers, University of Washington.	99.15	Trace.				.27		[a].56	P_2O_5, 0.02 per cent	100.00

Roche Harbor	Tacoma & Roche Harbor Lime Co.		98.32					1.13		.44	P_2O_5, 0.11 per cent	100.00
Tuckawila	Pacific Coast Portland Cement Co.	Robt. H. Heath	94.50					1.15		.70	H_2O and organic, 3.20 per cent.	99.55
Spokane County:												
Milan	Spokane Marble Co.	Washington Geological Survey.			13.05	27.74	11.33	2.08	2.32	27.93	FeO, 2.38 per cent; H_2O and undetermined, 13.17 per cent.	100.00
Stevens County:												
Colville (white)	Crystal Marble Quarries Co.	R. W. Thatcher Pullman.			31.80	20.68	46.64			[a].91	Fe, trace	100.03
Colville (mottled)	do	do			30.08	22.21	46.79			[a].98	do	99.97
Colville	Jefferson Marble, Mining & Milling Co.	Washington Geological Survey.			55.11	.21	43.77	Trace.		.87	H_2O, 0.05 per cent	100.01
Do	do	do			51.54	1.11	42.36	.24	Trace.	3.49	FeO, trace; H_2O, 0.10 per cent.	98.84
Mettaline Falls	Inland Portland Cement Co.	Chas. R. Ranch	90.30	3.56				2.18		2.86		98.90
Do	do	do	87.80	3.48				3.04		4.40		98.72
Do	do	do	91.40	2.92				3.02		2.48		99.82
Do	do	do	97.50	Trace.				.76		.92		99.18
Whatcom County:												
Sumas	International Lime Co.	A. H. Cederberg	98.72	.26				.42		1.37		100.77
Do	do	Robert S. Edwards, Portland, Oreg.	72.91	.41			Trace.	.55		.63	Moisture, 25.50 per cent.	100.00
Do	do	Mutual Eng. Co., San Francisco.			54.60	.36	[c]42.98		.29	1.32	FeO, 0.21 per cent; alkalies, 0.24 per cent.	100.00
WEST VIRGINIA.												
Berkeley County:												
Martinsburg	Security Cement & Lime Co.	Wuth & Stafford, Pittsburgh, Pa.	99.21	.55					.03	.17		99.96
Greenbrier County:												
Fort Spring	Snowflake Lime & Rock Co.	J. Blodget Britton, Warrenton, Va.	96.46	1.11					1.46	.97	P, trace; loss on ignition, trace.	100.00
Jefferson County:												
Millville	Harpers Ferry Stone & Lime Co.	H. M. Randall	97.85	.76					.34	.90	$FeCO_3$, trace	99.85
Do	do	do	88.79	4.77					.95	4.00	$FeCO_3$, 0.45 per cent	98.96
Shepherdstown	Wm. J. Knott & Sons	U. S. Department of Agriculture.			55.65	.38	42.69	.43		[a].52		99.72
Wayne County:												
Kenova	Basic Products Co.	Ironton Iron Co., Ironton, Ohio.	55.00	43.82					.07	.20	P, 0.001 per cent; FeO, 0.29 per cent.	99.38
Do	do	A. T. Wood	55.90	43.90					.54	.42	FeO, trace	100.76

[a] Insoluble in acid.

[b] Sample dried at 212° F.

[c] Loss by ignition.

Analyses of limestone quarried in the United States, by States—Continued.

Location.	Operator or owner.	Authority.	Calcium carbonate ($CaCO_3$).	Magnesium carbonate ($MgCO_3$).	Calcium oxide (CaO).	Magnesium oxide (MgO).	Carbon dioxide (CO_2).	Ferric oxide (Fe_2O_3).	Aluminum oxide (Al_2O_3).	Silica (SiO_2).	Other minerals.	Total.
WISCONSIN.												
Bayfield County:			*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*		*Per ct.*
Washburn	W. G. & D. N. Maxey	C. W. Hall, University of Minnesota.	52.483	41.939					1.966	0.614	$FeCO_3$, 2.177 per cent	99.179
Calumet County:												
Brillion	Union Lime Co	Gustave Bode, Milwaukee, Wis.	52.83	46.61				0.12	.20	.24		100.00
Do	do	do	55.09	43.96					.36	.59		100.00
Dodge County:												
Knowles	Nast Bros. Lime & Stone Works.	W. W. Daniels, University of Wisconsin.	54.30	45.32				.24		*a*.28		100.14
Do	Standard Lime & Stone Co.	Wisconsin Geological Survey.	54.740	45.070				.05		.022		99.837
Mayville	Mayville White Lime Works.	Chemist, Milwaukee Brewing Academy.	58.02	39.90						*b*.5715	P_2O_5, 0.216 per cent	98.7075
Watertown	Frank Cowen	H. S. Witmer, Wyandotte, Mich.	61.91	32.40				1.08		3.24		98.63
Do	do	do	55.41	40.40				1.24		2.84		99.92
Door County:												
Sturgeon Bay	Leathem & Smith Towing & Wrecking Co.	A. S. Mitchell, State chemist.	51.42	44.88				.84		*a*2.04	K_2O and Na_2O, *c* 0.82 per cent.	100.00
Do	do	do	49.59	42.93				1.44		*a*4.76	K_2O and Na_2O, *c* 1.28 per cent.	100.00
Do	do	do	51.35	43.11				.96		*a*3.56	K_2O and Na_2O, *c* 1.02 per cent.	100.00
Do	do	do	51.45	43.31				.92		*a*3.24	K_2O and Na_2O, *c* 1.08 per cent.	100.00
Fond du Lac County:												
Hamilton	Union Lime Co	W. W. Daniels, University of Wisconsin.	54.25	44.48				.26	.10	*a*.67	H_2O, 0.11 per cent	99.87
Oakfield	Standard Lime & Stone Co.	do	54.40	44.43				.48		.69		100.00
Manitowoc County:												
Valders	do	A. S. Mitchell, State chemist.	54.38	44.39				.38	.20	.24		99.59
Ozaukee County:												
Druecker	Independent Lime & Stone Co.	Gustave Bode, Milwaukee, Wis.	55.41	43.48								98.89
Do	do		56.00	43.00					1.00			100.00

Pierce County:												
Elmwood	Spring Valley Iron & Ore Co.	G. L. Fitzwilliams			30.62	26.12	d35.561	1.18		5.30	Fe, 0.107 per cent; Mn. 0.10 per cent; P, 0.012 per cent.	100.00
Do	do				31.54	20.56	d39.465	1.20	2.15	5.00	MnO, 0.06 per cent; P, 0.010 per cent; S, 0.015 per cent.	100.00
Do	do				29.24	20.13	d44.73	.93	.25	4.72		100.00
Spring Valley	do	Company chemist	52.55	41.77				.57	1.22	4.57		100.68
Do	do	F. E. Budd			29.45	20.30	d44.07	2.26		3.92		100 00
Do	do	Company chemist			29.50	19.60	d45.20	1.20	.50	4.00		100.00
Racine County:												
Ives	John O'Laughlin Stone Co.	Robert W. Hunt & Co., Chicago, Ill.			30.80	21.49	45.00	1.00	.34	.32		98.95
Racine (yellow stone).	Racine Stone Co	do	53.93	45.36				.30		.32		99.91
Racine (blue stone)	do	do	54.10	45.05				.34		.44		99.93
Do	Universal Crushed Stone Co.	do	55.36	44.01						.22		99.59
St. Croix County:												
Glenwood	H. J. Baldwin	Allis-Chalmers Co., Chicago, Ill.	47.37	40.42				1.85		a10.36		100.00
WYOMING.												
Albany County:												
Laramie	W. H. Holliday & Co.	H. G. Knight, University of Wyoming.			55.34	.21	43.73	.12	.10	.43	H_2O, 0.05 per cent	99.98
Carbon County:												
Rawlins	H. Larsen	Colorado-Wyoming Chemical Co.	98.69	.42				.30	Trace.	.32	H_2O, 0.27 per cent	100.00
Laramie County:												
Guernsey	Guernsey Lime Co	E. E. Burlingame & Co., Denver, Colo.	99.38					.11		.39		99.88
Hartville	do	Colorado Fuel & Iron Co.	99.43					.22		.30	P, 0.001 per cent	99.951
Do	do	Great Western Sugar Co.	99.215					.34		a.16	Undetermined, 0.285 per cent.	100.00

a Insoluble in acid. b Silicates. c Contains also organic matter. d Carbon dioxide and undetermined.

Analyses of lime are given in the following table:

Analyses of lime manufactured in the United States, by States.

Location.	Owner or operator.	Authority.	Calcium oxide (lime) (CaO).	Magnesium oxide (MgO).	Ferric oxide (Fe_2O_3).	Aluminum oxide (Al_2O_3).	Silica (SiO_2).	Other minerals.	Total.
ALABAMA.									
Etowah County:			*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*		*Per cent.*
Rock Springs	J. G. Thompson		98.00						98.00
Jefferson County:									
Birmingham	Tennessee Coal, Iron & R. R. Co.	J. R. Harris	96.91			0.64	1.54	MnO, 0.59 per cent	99.68
Vanns	do	do	96.41	0.44	0.73		1.93		99.51
Shelby County:									
Longview	Longview Lime Works	A. L. Metz, Louisiana State Board of Health.	97.30		.21		.37	$CaCO_3$ 1.55 per cent; $MgCO_3$, 0.56 per cent.	99.99
Do	do	Louisiana Sugar Experiment Station.	98.44	.98	.26		*a*.18	CO_2, 0.32 per cent	100.18
Saginaw	Bowden Lime Works	J. C. Long	99.49	.17	.10	.04	.13	H_2O, 0.04 per cent; P, trace; S, trace; not determined, 0.03 per cent.	100.00
Do	do	Eugene A. Smith	99.89	Trace.	.09		*a*.10		100.08
Do	Saginaw Lime & Lumber Co.	J. C. Long	99.30	.31	.17	.03	.10	H_2O, 0.04 per cent; undetermined, 0.043 per cent; P, 0.007 per cent.	100.00
ARKANSAS.									
Benton County:									
Brightwater	Southern White Lime Co	W. E. Thompson, Little Rock.	97.54						97.54
Rogers	do	R.W. Hunt & Co., Chicago, Ill.	94.97	.35	.24	.37	.81	S, 0.01 per cent; loss, 2.98 per cent.	99.73
CONNECTICUT.									
Fairfield County:									
Bethel	Plumtrees Lime Co	S. P. Wheeler, State chemist.	63.50	18.00	Trace.		18.50		*b* 100.00
Danbury	Stearns Lime Co		92.59	2.38	.36		2.56		97.89
Do	do		96.66	.52	.22		1.36		98.76
Do	do		91.92	.54			.54		93.00
Litchfield County:									
Canaan	Connecticut Western Lime Co.	J. S. Adams	65.00	34.00					99.00
Do	New England Lime Co	do	56.57	42.56				CO_2 and H_2O, 0.10 per cent; Al_2O_3 and SiO_2, 0.42 per cent.	99.65

GEORGIA.									
Bartow County: Cartersville	Ladd Lime Co	State mineralogist	34.07	55.736	1.236		7.252	H_2O, 1.622 per cent.	99.916
Floyd County: Rome	Jno. H. Hawkins	P. H. Carter	97.70	....	.46		.97	$MgCO_3$, 0.87 per cent	100.00
HAWAII.									
Hawaii County: Honolulu	Waianae Lime Co	Hawaii Sugar Association	98.11	.96	.21		a .01	H_2O, 0.73 per cent; H_2SO_4, 0.52 per cent.	100.54
Do	do	S. Johnson	97.84	.90	.24		.03	H_2O, 0.80 per cent; H_2SO_4, 0.56 per cent.	100.37
ILLINOIS.									
Madison County: Alton	Alton Lime & Cement Co	St. Louis Sampling & Testing Works, St. Louis.	98.32	.32	.40		a .34	Loss on ignition, 0.50 per cent.	99.88
Upper Alton	Jno. Armstrong Lime & Quarry Co.	S. E. Swartz, Upper Alton	97.72	None.	....	1.10	1.01	FeO, 0.20 per cent; H_2O and loss, 0.14 per cent.	100.17
Rock Island County: Port Byron	Port Byron Lime Association	W. A. Powers, Topeka, Kans.	61.90	35.28	.60		.60	....	98.38
Whiteside County: Fulton	Alden Lime Co	....	56.80	39.68	.90	.96	.36	Loss, 0.22 pe cent.	98.92
Do	do	....	58.75	34.47	2.12		1.54	Loss, 2.91 per cent; S, 0.03 per cent.	99.82
INDIANA.									
Delaware County: Muncie	Muncie Stone & Lime Co	Laboratory De Pauw University.	58.32	40.12	....	.66	a 1.04	H_2O, 0.15 per cent; $CaSO_4$, 0.15 per cent.	100.44
Huntington County: Huntington	Ohio & Western Lime Co	W. S. Blatchley, Indianapolis.	59.20	38.38	.49		.35	CO_2 and H_2O, 1.80 per cent.	100.22
Jay County: Portland	A. & C. Stone & Lime Co	J. V. Hurty	60.08	38.62	.80		.50	....	100.00
Madison County: Alexandria	Hoosier Rock Wool Co	Laboratory, Republic Iron & Steel Co.	78.30	....	....	5.30	16.40	....	100.00
IOWA.									
Cerro Gordo County: Mason City	Mason City Lime & Cement Co.	Geo. P. Dieckmann	98.83	.65	.12	.03	.49	....	100.12
Do	do	S. W. Beyer, Iowa Agricultural College, Ames.	96.25	.24	1.24		.60	H_2O, 1.44 per cent	99.77

a Insoluble in acid.

b Fluxing carbonate, 98.57 per cent.

Analyses of lime manufactured in the United States, by States—Continued.

Location.	Owner or operator.	Authority.	Calcium oxide (lime) (CaO).	Magnesium oxide (MgO).	Ferric oxide (Fe_2O_3).	Aluminum oxide (Al_2O_3).	Silica (SiO_2).	Other minerals.	Total.
MAINE.									
			Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*		*Per cent.*
Knox County: Rockland	A. D. Bird & Co	R. S. Edwards, Rockland	96.10	1.28	1.27		0.57	CO_2 and H_2O, 0.78 per cent.	100.00
Thomaston	A. J. Bird	do	95.91	.23	....	....	.62	$FeCO_3$ and Al_2O_3, 0.39 per cent; H_2O, 2.85 per cent.	100.00
Waldo County: Center Lincolnville	Coleman, Wheelright & Merrill.	O. W. Knight, Bangor, Me	56.95	35.91	....	....	5.36	$FeCO_3$ and Al_2O_3, 1.45 per cent; undetermined, 0.33 per cent.	100.00
MARYLAND.									
Baltimore County: Texas	Wm. P. Lindsey	Penniman & Brown, Baltimore.	97.21	.64	.25		.86	SO_3, 0.23 per cent; CO_2 and H_2O, 0.81 per cent.	100.00
Carroll County: Union Bridge	Tidewater Portland Cement Co.	E. A. Slagle	96.08	.73	.68		2.13	....	99.62
Frederick County: Frederick	Tabler Lime & Stone Co	Dr. A. W. Nebelius, Emporium, Pa.	93.53	3.23	1.28		1.96	....	100.00
Le Gore	Le Gore Combination Lime Co.	Delaware State chemist	97.50	1.40	.20		1.16	....	100.26
Do	do	do	97.54	1.20	.21		1.01	....	99.96
Do	do	Maryland State chemist	96.00	1.08	1.20		1.63	Undetermined, 0.09 per cent.	100.00
Do	do	do	97.61	.43	1.07		.89	....	100.00
Do	do	do	97.00	.43	1.60		.41	Undetermined, 0.56 per cent.	100.00
Do	do	do	96.80	.72	1.80		.68	....	100.00
MASSACHUSETTS.									
Berkshire County: Cheshire	Whitney Bros	Ricketts & Banks, New York, N. Y.	97.44	.79	.41	Trace.	.60	CO_2 0.27 per cent; SO_3, 0.38 per cent; K_2O, trace.	99.89
Clayton	Hodsell Lime Co	J. L. Jackson, Brooklyn, N. Y.	82.30	1.74	....	4.02	11.10	....	99.16
Lee	Lee Lime Co	M. L. Griffin, Mechanicsville, N. Y.	54.22	42.50	.50		*a*.50	....	97.72

New Lenox	New England Lime Co	W. M. Habershaw, New York State Agricultural Society.	95.66	.76	.17		1.14	Loss on ignition, 3 per cent.	100.73
North Adams	Whitney Bros	Prof. Leverett Mears, Williams College.	97.48	.45	.12	Trace.	.19	CO_2, 0.10 per cent; SO_3, 1.37 per cent; K_2O, trace; Na_2O, trace.	99.71
Renfren	New England Lime Co	P. S. Burns	98.13	.42	......	.15	.36	CO_2, 0.60 per cent; H_2O, 0.20 per cent.	99.86
Do	do	H. P. Eddy	96.63	.88	.47		.81	Loss on ignition, 0.12 per cent.	98.91
West Stockbridge	West Stockbridge Lime Co	R. S. Edwards	90.99	2.55	.48		[a]4.70	......	98.72
MICHIGAN.									
Alpena County: Alpena	R. Collins	Chemist, Lake Superior Carbide Works, Sault Ste. Marie.	95.60	.14	.94		1.96	CO_2, 1.36 per cent.	100.00
Do	do	do	94.26	.32	1.21		3.42	CO_2, 0.79 per cent.	100.00
Arenac County: Omer	M. J. Griffen	E. J. Schneider, Michigan Geological Survey.	93.44	2.99	1.54		1.81	......	99.78
Do	do	do	95.89	.53	1.32		.16	......	97.90
Do	do	do	96.96	.49	......	1.42	1.67	......	100.54
Charlevoix County: Bay Shore	Elk Cement & Lime Co	do	81.83	13.42	......	1.74	1.09	CO_2, 1.92 per cent.	100.00
Do	do	do	96.80	.67	......	.66	.70	CO_2, 1.17 per cent.	100.00
Schoolcraft County: Manistique	White Marble Lime Co	J. P. Griffith, Manistique	64.72	33.75	.40		2.10	......	100.97
MINNESOTA.									
Washington County: Stillwater	C. H. Carli	W. Lehman, St. Paul	51.96	20.00	4.00	6.04	13.30	CaS, 4.70 per cent.	100.00
MISSOURI.									
Cooper County: Wooldridge	Central Missouri Lime Co	Regis Chauvenet & Sons, St. Louis.	99.77	.05	......	......	......	FeO, 0.18 per cent.	100.00
Pike County: Louisiana	Marble Head Lime Co	H. E. Horton	97.46	.77	.40		.54	CO_2, 0.37 per cent; loss on ignition, 0.69 per cent; unburned stone, 0.84 per cent.	101.07
Ste. Genevieve County: Ste. Genevieve	Western Lime Works	Regis Chauvenet & Sons, St. Louis.	97.90	.23	......	......	Trace.	H_2O, 1.87 per cent.	100.00
MONTANA.									
Powell County: Elliston	Elliston Lime Co	Emil Starz, Helena	97.78	1.08	.69		.45	......	100.00

[a] Insoluble in acid.

Analyses of lime manufactured in the United States, by States—Continued.

Location.	Owner or operator.	Authority.	Calcium oxide (lime) (CaO).	Magnesium oxide (MgO).	Ferric oxide (Fe_2O_3).	Aluminum oxide (Al_2O_3).	Silica (SiO_2).	Other minerals.	Total.
NEW YORK.									
Clinton County:			*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*		*Per cent.*
Chazy	Chazy Marble Lime Co	Enrique Touceda, Troy	97.08	1.40	0.12	0.14	0.79		99.53
Genessee County:									
Le Roy	John Heimlich		94.00	1.40	1.10	.30	3.20		100.00
Jefferson County:									
Chaumont	Adams & Duford Co		97.95	.88	.66		.21	S, 0.30 per cent.	100.00
Natural Bridge	New York Lime Co		91.59	5.85	.23	.15	1.34		99.16
Do	do		54.85	43.15	.46		.41		98.87
Do	do		92.43	5.85	.38		1.34		100.00
Onondaga County:									
Jamesville	E. B. Alvord & Co	F. E. Englehart, Syracuse	91.93	3.06	2.03		a 1.88	SO_3, 0.73 per cent.	99.63
Onondaga	Solvay Process Co	J. D. Pendock	95.39	1.109	1.409		2.095		100.003
St. Lawrence County:									
Richville	Chas. Williams & Co	J. M. Adams, Watertown	86.25	13.50		.25			100.00
Warren County:									
Glens Falls	Sherman Lime Co	International Paper Co., Glens Falls.	98.03	.71	.15	.06	1.05		100.00
Do	F. W. Wait Lime Co	M. R. Griffin, Albany	97.00	.36	.80		.14	H_2O, 1.10 per cent.	100.00
Washington County:									
Smiths Basin	Keenan Lime Co	Albany & Rensselaer Iron & Steel Co., Albany.	94.07	.79	.07	.20	1.93	P_2O_5, 0.01 per cent; CO_2, 3.04 per cent.	100.11
Do	do	do	95.50	Trace.	.58		a 1.06	CO_2 and H_2O, 02.08 per cent.	99.22
OHIO.									
Clark County:									
Springfield	W. A. Rubsam	Crowell & Peck, Cleveland	54.28	44.10	.93		.60	P, 0.004 per cent; S, 0.006 per cent.	99.92
Crawford County:									
Bucyrus	Broken Sword Stone Co	S. V. Peppel, Columbus	86.45	7.23	.15	.69	2.94	CO_2, 0.44 per cent; H_2O, 2.66 per cent.	100.56
Do	do	do	69.42	7.37	.15	.55	2.40	CO_2, 1.09 per cent; H_2O, 19.06 per cent.	100.04
Delaware County:									
Delaware	The Scioto Lime & Stone Co	R. S. Edwards, Boston, Mass	94.60	2.79	.55		2.06		100.00
Hardin County:									
Patterson	Jno. Herzog & Son		68.00	24.00	.625	3.00		H_2O, 4 per cent.	99.625
Lawrence County:									
Campbell	Vernon Iron Co	Ernest Evans, Zanesville	93.90	2.23	1.10		.60	H_2O, 0.10 per cent; P, 0.012 per cent.	97.942

Ottawa County:									
Clay Center	Kelley Island Lime & Transport Co.	W. J. Rattle & Sons, Cleveland.	62.60	37.16	.50		.16	P, 0.007 per cent; S, 0.173 per cent.	100.60
Sandusky County:									
Bellevue	The Bellevue Stone Co.		59.24	33.34	2.86	2.20	1.56	P. 0.063 per cent; S, 1.56 per cent.	100.823
Do	do		58.29	32.95	5.52		3.26	P, 0.021 per cent; S, 0.041 per cent.	100.082
Do	do		53.40	34.87	7.12		4.72	P, 0.025 per cent, S, 0.211 per cent.	100.346
Gibsonburg	Ohio & Western Lime Co.	Wuth & Stafford, Pittsburgh, Pa.	58.481	39.346	.046	.070	.122	H_2O, 1.935 per cent	100.00
Woodville	Woodville Lime & Cement Co.	do	58.20	36.26	.071	.09	.37	H_2O, 5.01 per cent	100.001
Do	do		48.72	32.47	.50		.10	Loss, 18.21 per cent	100.00
Seneca County:									
Tiffin	West Lime & Stone Co.	Prof. Knetchner, Tiffin	58.50	38.00	Trace.	Trace.	Trace.	H_2O, 3 per cent	99.50
Stark County:									
Howenstine	Farmers Lime & Fertilizer Co.		66.22	2.25	7.28			H_2O, 22.32 per cent; Na_2O and K_2O, 1.93 per cent.	100.00
Wood County:									
Portage	Ohio & Western Stone & Lime Co.		58.90	38.75	.04	.13	1.70	H_2O, 0.48 per cent	100.00
Wyandot County:									
Carey	National Lime & Stone Co.	Pittsburgh (Pa.) Metallurgical Laboratory.	57.74	41.20	.86		.19		99.99
OKLAHOMA.									
Johnson County:									
Bromide	Bromide Oolithic Stone Works.	Erasmus Haworth, Lawrence, Kans.	97.83	.49	.52		.80		99.64
PENNSYLVANIA.									
Adams County:									
Bittinger	John R. Bittinger		92.00	3.55	.03		.53	K_2CO_3, 4.23 per cent	100.34
Center County:									
Pleasant Gap	White Rock Quarries	E. S. Erb, State College	98.344	1.048	.379		a.499		100.27
Do	do	D. E. Wasburn, Bellefonte	91.28	.24	.20		.34		92.06
Chester County:									
Devault	Charles Warner Co., Whiteland plant.	Dr. E. W. Lazell	57.12	38.94	.84		2.04	Loss, 0.92 per cent	99.86
Do	Charles Warner Co., Cedar Hollow plant.	do	56.64	38.56	1.16		1.68	Loss, 1.62 per cent	99.66
Dauphin County:									
Hummelstown	Vulcanite Limestone Co.	Vulcanite Portland Cement Co.	95.00	2.00		1.50	1.50		100.00
Paxtang	Paxtang Quarry Co.		97.03	1.05		.21	2.15	Fe, 0.12 per cent	100.56
Do	do		99.00	Trace.		.22	.76	Fe, 0.12 per cent	100.10
Steelton	Geo. W. Cumbler		85.60	10.00			3.00		98.00
Lancaster County:									
Salunga	C. F. Bacon		95.00				5.00		100.00

[a] Insoluble in acid.

Analyses of lime manufactured in the United States, by States—Continued.

Location.	Owner or operator.	Authority.	Calcium oxide (lime) (CaO).	Magnesium oxide (MgO).	Ferric oxide (Fe_2O_3).	Aluminum oxide (Al_2O_3).	Silica (SiO_2).	Other minerals.	Total.
PENNSYLVANIA—contd.									
			Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*		*Per cent.*
Lawrence County:									
Ellwood City	Beaver Valley Lime Co	A. C. Hasse, New Castle	86.39	1.09	3.92		4.53	Loss, 4.05 per cent	99.98
Lebanon County:									
Palmyra	Walter T. Bradley	Hamlin & Morrison	95.80						95.80
Mercer County:									
Volant	Oakes Bros	Walter Tharp, jr	71.92	.77	3.63	5.61	1.04	P, 0.032 per cent	83.002
Montgomery County:									
Bridgeport	Charles Warner Co	Charles I. Reader	58.33	37.37	1.35		2.95		100.00
Do	do	Dr. E. W. Lazell	55.33	38.45		2.57	3.82		100.17
Plymouth Meeting	do	do	56.18	39.03		1.79	3.03		100.03
Northampton County:									
Easton	Annville Stone Co	do	96.96	.94	5.10		1.46		104.46
Northumberland County:									
Dalmatia	B. F. Heckert	Dr. Wm. Frear, State chemist	81.38	1.34	6.80		2.43	CO_2, 7.05 per cent; P_2O_5, 0.35 per cent; H_2O, 0.65 per cent.	100.00
Shamokin	George Martz		98.00	2.35					100.35
York County:									
Thomasville	Thomasville Stone & Lime Co.	A. W. Phillips	98.52	1.25	.23			CO_2, trace	100.00
RHODE ISLAND.									
Providence County:									
Lime Rock	Herbert Harris	F. W. Strickland, Providence.	83.84	8.891	.626		1.284	Volatile, 5.357 per cent.	99.998
Do	do	do	90.148	3.116	.619		1.517	Volatile, 4.591 per cent.	99.991
SOUTH DAKOTA.									
Custer County:									
Pringle	Black Hills Lime Co	Golden Reward Consolidated Gold Mining & Milling Co.	92.80	Trace.	3.10		.90	CO_2 and H_2O, 3.20 per cent.	100.00
Meade County:									
Piedmont	Homestake Mining Co	Company chemist	88.60	2.30	1.20		a 2.50	CO_2 and HO_2, 4.20 per cent.	98.80
TENNESSEE.									
Cumberland County:									
Crab Orchard	Crab Orchard Lime Works	Childress & Hunter, Knoxville.	97.01	.90	.60		1.25	$CaCO_3$, 0.20 per cent	99.96

Dickson County: Burns	Jesse Allen & Co	Brown Laboratory (Inc.), Nashville.	96.53	.21	2.31		....	Slacked and unburned, 1.01 per cent.	100.09
Franklin County: Sherwood	Gager Lime & Manufacturing Co.	Proctor & Gamble Co., Cincinnati, Ohio.	97.89	....	.22		.56	$CaCO_3$, 0.27 per cent; $MgCO_3$, 1.05 per cent.	99.99
Houston County: Erin	F. W. Rauscher	J. C. Wharton, Nashville	97.82	....	0.23	0.13	2.43	$CaCO_3$, 1.27 per cent; MgO, 0.12 per cent.	102.00
TEXAS.									
Comal County: New Braunfels	Dittlinger Lime Co	H. E. Bachtenkirchter, Chicago, Ill.	b 72.80	Trace.	1.24		.42	Moisture, 25.27 per cent; undetermined, 0.27 per cent.	100.00
Travis County: McNeil	Austin White Lime Co	Prof. James R. Bailey, University of Texas.	97.46	....	.15		a .25	Loss by ignition, 1.41 per cent; undetermined, 0.73 per cent.	100.00
Do	do	....	97.82	....	.16		a .15	Loss by ignition, 1.02 per cent; undetermined, 0.85 per cent.	100.00
Williamson County: Round Rock	Wm. Walsh & Co	O. H. Palm, University of Texas.	99.05	.21	Trace.		.40	SO_3, trace; CO_2, trace	99.66
UTAH.									
Utah County: Provo City	Thos. Boardman	Utah-Idaho Sugar Co	98.50	....	....	....	1.50	....	100.00
Do	do	do	94.00	....	....	....	6.00	....	100.00
VERMONT.									
Addison County: Leicester Junction	Brandon Lime & Marble Co	C. T. Lee, Boston, Mass	98.262	.299	.647	....	.383	$CaCO_3$, 0.409 per cent	100.00
Do	Leicester Marble Lime Co	State Assayer, Providence, R. I.	97.00	.936	.10		a .60	CO_2, c 1.30 per cent	99.936
Middleburg	Green Mountain Lime Co	R. S. Edwards, Boston, Mass.	98.40	.71	.24	....	.62	....	99.97
Bennington County: North Pownal	New England Lime Co	R. Schuphaus	98.14	1.40	.08	.11	.27	....	100.00
Franklin County: High Gate Springs	L. H. Fellon	Prof. S. P. Sharpless	99.80	....	....	....	....	....	99.80
St. Albans	W. B. Fonda	F. C. Robinson, Bowdoin College, Brunswick, Me.	99.26	.60	Trace.	Trace.	.14	....	100.00
Swanton	J. P. Rich	do	99.29	.46	....	Trace.	.10	MnO, trace; FeO, 0.12 per cent;	99.97
Do	do	C. Sharpless	98.47	1.12	Trace.	....	Trace.	CO_2, 0.45 per cent	100.04
Do	do	J. R. Chilton	98.84	.12	....	....	.02	CO_2, 1.02 per cent	100.00

a Insoluble in acid.
b Hydrated lime.
c Carbon dioxide and moisture.

Analyses of lime manufactured in the United States, by States—Continued.

Location.	Owner or operator.	Authority.	Calcium oxide (lime) (CaO).	Magnesium oxide (MgO).	Ferric oxide (Fe_2O_3).	Aluminum oxide (Al_2O_3).	Silica (SiO_2).	Other minerals.	Total.
VIRGINIA.									
Botetourt County:			*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*		*Per cent.*
Compton Bridge	J. L. Burks		45.00	52.50			2.50		100.00
Indian Rock	Chas. L. Wilson	Alleghany Iron & Ore Co.	99.50						99.50
Frederick County:									
Winchester	George V. Oyler		94.35	.52					94.87
Rockbridge County:									
Lexington	Rockbridge Lime & Stone Co.	H. Froehling	97.50						97.50
Sherwood	Natural Bridge Lime Co.		57.80	38.03	.51		.11	CO_2 and H_2O, 3.62 per cent.	100.07
Shenandoah County:									
Tomsbrook	Rockdale Lime Co.	Chemist, Longdale Iron Co.	88.71	7.40	.72		2.73		99.56
Do	do	do	95.49	2.93	.32		.74		99.48
Do	do	do	97.22	1.36	.27		.71		99.56
WASHINGTON.									
San Juan County:									
Deer Harbor	Arcas Lime Co.		98.00	.75	1.25				100.00
East Sound	Langdon Lime Co.	Caine & Grimshaw Co. Seattle, Wash.	97.00	.40			.46	Loss, 1.90 per cent	99.76
Stevens County:									
Evans	Idaho Lime Co.	C. S. Batchelder	98.20	.15	.22	.30	.90		99.77
WEST VIRGINIA.									
Preston County:									
Terra Alta	Terra Alta Lime Co.	Hazel Altas Glass Co., Fairmont.	96.38	.87		.56	1.65	FeO, 0.22 per cent	99.68
WISCONSIN.									
Door County:									
Sawyer	Green Stone & Quarrying Co.	F. W. Woll, Madison	77.19	16.79	.30		a 5.37	Undetermined, 0.35 per cent.	100.00
Do	do	do	87.16	11.73	.05		a .78	Undetermined, 0.28 per cent.	100.00
Do	do	do	75.37	22.67	.13		a 1.39	Undetermined, 0.44 per cent.	100.00
Do	do	do	81.98	15.24	.08		a 2.25	Undetermined, 0.45 per cent.	100.00
Do	do	do	60.68	37.16	.10		a 2.06		100.00

Do	do	do	78.58	19.80	.05		*a* 1.43	Undetermined, 0.14 per cent.	100.00
Manitowoc County:									
Manitowoc	Rockwell Lime Co	Chemical & Engineering Co., Chicago, Ill.	60.23	26.90	3.33		*b* 2.83	H_2O, 0.10 per cent; undetermined, 6.61 per cent.	100.00
Sheboygan County:									
Sheboygan	Sheboygan Lime Works	Gustave Bode, Milwaukee	55.49	42.31		1.10	.46	CO_2, 0.64 per cent	100.00
Do	do	Davenport Firches, Milwaukee.	56.22	40.35	.37	.56	.78	CO_2 and H_2O, 1.56 per cent.	99.84
WYOMING.									
Laramie County:									
Guernsey	Guernsey Lime Co		99.43						99.43

a Insoluble in acid.

b Includes clay.

TECHNOLOGIC INVESTIGATIONS OF LIME.

TESTS OF LIME.

In June, 1909, the United States Geological Survey, in cooperation with the National Lime Manufacturers' Association, began a study of lime. Both field and office work were undertaken. In the field the conditions prevailing as to quarrying, crushing, burning, and hydrating were studied, and samples of stone, burned lime, and hydrated lime were collected from a wide territory embracing nearly all the States east of Missouri River and from quarries in various types of stone, grading from high-calcium to highly magnesian lime. In collecting the samples of stone the geologic formations in which the quarry was situated were noted, as well as the dip and strike of beds and their lithologic and structural features that might have a bearing on the quarrying and utilization of the stone. In the laboratory, which was situated at Pittsburgh, Pa., the work included chemical analyses and physical tests of the limestone and chemical and physical tests of quick lime and hydrated lime. The principal aim of the investigation is to show the effect of impurities contained in various limes, the effect of low and high temperatures on the quality of the lime burned, the different degrees of plasticity produced by different limes, the strength of the lime mortars, and to determine, if possible, the best conditions for hydration. The work was carried on for about one year under the United States Geological Survey, but on July 1, 1910, the structural-materials laboratories at Pittsburgh were transferred to the Bureau of Standards, under which organization the work has been continued. The laboratory work has been performed principally by W. E. Emley, assistant chemist. Some preliminary results have been published by the National Lime Manufacturers' Association and by the Bureau of Standards, as indicated in the list of publications at the end of this chapter.

The quality of lime has become so important to the consumer that it is necessary to devise specifications which shall serve as a basis for mutual understanding between consumer and manufacturer. Such specifications involve a thorough study of the properties of lime, how these properties must vary to meet the demands of different consumers, what tests must be made to indicate to what degree any limestone or any lime possesses these properties, and how to make the tests. For building limes the factors of most importance are sand-carrying capacity, crushing strength, and tensile strength; for plastering limes these factors are spreading quality, time of setting, color, hardness, and constancy of volume. Mr. Emley has made a preliminary statement of tentative tests as follows:[1]

> To all users of lime the content of carbon dioxide is important as indicating to what extent the lime has air-slaked or spoiled. The rate of hydration is also important as a means of determining whether or not the lime has been properly burned.
>
> For chemical or agricultural uses a complete chemical analysis, or at least the determination of calcium oxide, becomes necessary.
>
> Building lime should be tested for crushing strength, tensile strength, and sand-carrying capacity.
>
> For plastering lime the time of set, plasticity, color, hardness, and constancy of volume are important.
>
> Since the chemical analysis of lime is of more interest to the chemist than to the technical man, mere references will be made to some new, quick methods.

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[1] Emley, W. E., Tests of lime: Trans. Nat. Lime Mfrs. Assoc., 1911, pp. 192–194.

The carbon dioxide can be determined by means of an alkalimeter, the rate of hydration by means of a calorimeter. The color may be measured by direct comparison with a series of standards. These standards consist of mixtures of chemically pure calcium carbonate and lead peroxide in various proportions, giving all shades from white to brown. By the use of a viscosimeter, the viscosities of lime paste with different quantities of water can be determined, and a correlation of these should give a comparative indication of the spreading quality. It has been found necessary, in determining viscosities, to have some standard means of preparation of the sample. For this purpose a uniform-temperature slaking apparatus has been devised. The Clark viscosimeter is being used for thin pastes; a plunger viscosimeter is also in use. For all other tests a standard lime paste must be used.

A standard lime paste may be prepared as follows: Determine the viscosity of a paste which has the proper consistency for practical work. Call this the standard viscosity. Then, from the viscosities of pastes made with different quantities of water, find by interpolation how much water is required to give a paste of the standard viscosity with the particular lime in question. This quantity of water is to be used in mixing pastes for the succeeding tests, and the paste so produced shall be known as the "standard lime paste." By using this standard the consistencies of the pastes used will be identical, and therefore the results of the tests will be more nearly comparable.

For testing crushing strength and tensile strength use a mortar consisting of standard lime paste and sand, the sand being in the ration of 3 : 1 by weight to the dry lime. The molds for crushing specimens are to be cubes, 2 inches on a side; for tensile specimens, the customary briquets have a cross section of 1 square inch at the center. All specimens are to be stored in air and broken when three months old.

To test sand-carrying capacity, make up specimens as for crushing strength, except that the proportion of sand is to vary from 0 to 5 times the weight of the lime. Store and break as for crushing strength.

Some of these specimens containing no sand are to be measured when three months old, in order to determine the constancy of volume.

To determine the time of set, use the standard lime paste under a Vicat needle and follow the official specifications adopted for testing cement. That is, the initial set is said to have occurred when the needle penetrates to a point 5 millimeters from the bottom; the final set when there is no noticeable penetration.

Hardness is to be determined by exposing the standard lime paste, one week old, to the action of a sand blast and noting the rate at which it is worn off.

The tests outlined above are the ones it is hoped may be used in the original tentative draft of specifications. In order to arrive at these methods of testing many experiments were carried out.

In making tests along the lines indicated above, Mr. Emley found that samples of both quick and hydrated lime shipped to the laboratory in practically air-tight packages kept very well. In the case of hydrated lime shipped in commercial packages there was some deterioration, as shown by the amount of carbon dioxide absorbed. Experiments showed that the hydrated lime did not keep any better in air than ground quicklime, and it was not proved that hydrated lime may be stored indefinitely without spoiling. In the crushing and tensile-strength tests it was found that magnesian limes were stronger than high-calcium limes. Although this may be of some advantage in structural work, it is well known that high calcium lime possesses the requisite strength for nearly all practical purposes.

Another important subject under investigation by the Bureau of Standards is the burning temperature of limestone. According to Bleininger and Emley:[1]

> The problem of burning limestone would be a very simple one if we were dealing with pure carbonates. If this were the case the lime could not be overburnt under the conditions of burning, and likewise the magnesia would have a temperature range sufficiently wide for all practical purposes. Unfortunately this is not the case. All limestones carry impurities in the shape of clay, silica, iron oxide, alkalies, carbon,

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[1] Bleininger, A. V., and Emley, W. E., The burning temperature of limestone: Trans. Nat. Lime Mfrs. Assoc., 1911, pp. 68–69, also Trans. Am. Ceramic Soc., v. 13, 1911, pp. 618–638.

pyrites, etc. It happens that most of these impurities are more or less acid in character, being opposite in this respect to the lime and magnesia which are basic. Since there is, however, the tendency on the part of all acid and basic substances to combine to form compounds, it is evident that silica will produce silicates of lime and magnesia; alumina, aluminates; and ferric (iron) oxide, ferrates. While lime itself is practically infusible as far as industrial temperatures are concerned, the various silicates, aluminates, and ferrates are comparatively fusible. In heating limestone to its dissociation temperature, we are also causing heat to affect its impurities. A curious and interesting natural law begins to operate in this connection, the working out of which it is of interest to note. As soon as the stone is heated to about its practical dissociation temperature the impurities mentioned combine with the lime in such proportions that the resulting mixture begins to soften, indicating incipient fusion. In other words, the silica, alumina, and iron oxide combine with just sufficient lime to bring about this result, and no more. We are dealing hence with an automatic selection of a fusible matrix which is constant only for a certain temperature. On raising the temperature the amount of fusible matter increases, and hence its composition must change. It will bring into this matrix some more lime. Hence, as the temperature rises, the fluxes become more and more potent by combining with increasing amounts of lime. For instance, while an impure stone may be heated to, say, 1,830° F., and still produce a salable lime, at, say, 2,200° F., the impurities with their combined lime constitute such a large portion of the total mass, which on account of its softening closes up the pores and envelops the particles of lime by a slaglike coating, that the lime slakes but difficultly and hence has lost part or all of its commercial value.

It must be realized that there is another important function connected with the softening of the impurities and their quota of lime. In all rocks which have been heated to their incipient softening temperature a force is operative which tends to close up all the pores. A lump of limestone in the kiln might be imagined to be acted upon on all sides by surface forces which tend to contract it, to make it smaller, thus closing up all the poral spaces. In pure lime this force is ineffective, as there is no softening at these temperatures. It therefore remains porous, and it is practically impossible to overburn it.

The impurities of limestone for this reason not only are objectionable on account of their mere presence but much more so due to their action just described. This might be illustrated by an example. Supposing we are dealing with a limestone which has the following composition:

	Per cent.
Carbonate of lime	96.36
Carbonate of magnesia	.74
Silica	1.41
Alumina	.25
Ferric oxide	.40

What is the amount of lime actually available as such? Assuming that dicalcium silicate, tricalcium aluminate, and tricalcium ferrate are formed, we have left 96.36—(4.70 plus 0.75 plus 0.75) equals 90.16 per cent of carbonate which goes to make free lime. The impurities thus have withdrawn a share of the lime from active service. In addition they have closed up the pores of the lumps more or less and have hardened the structure.

The results of this investigation may be summarized as follows:

1. The minimum dissociation temperature of calcium carbonate was found to be 880° C., and of magnesium carbonate 750° C.

2. The limiting burning temperature of lime may be determined by a study of the hydration curves of limes burnt at different temperatures. In these curves the temperature rise of a certain weight of water heated by the slaking of a given amount of lime is platted against time. This method therefore offers a means of fixing the proper burning temperature for a given lime.

3. The maximum temperature permissible for pure high calcium stone is above 1,300° C., for impure high calcium stone it lies between 1,050° and 1,150° C., for pure magnesian stone between 1,000° and 1,050°, and for impure magnesian stone between 900° and 1,020°.

4. The porosity-temperature curve of a lime likewise gives valuable information in regard to the best burning temperature, which is represented by the point of maximum porosity. The slope of the curve from this point toward higher temperature is a significant measure of overburning. The steeper the slope, the greater this tendency and vice versa. The reduction in the porosity of lime as the temperature increases is due in part to the inherent contraction of the amorphous substance, in part to the fluxing effect of impurities.

5. The more porous a limestone is in its natural condition, the more easily will it burn—that is, the more rapidly and at a lower temperature. Porous stone may be completely burnt at 900°, whereas a denser stone requires at least 1,000° C. in the same length of time.

6. The density curve of a lime burnt at different temperatures expresses its degree of purity. The specific gravity curve of pure limes tends to rise with increasing temperature above 1,100° C.; the curve of the impure stone is depressed. The conditions for burning dolomitic limestones are probably more complex than for high calcium limestones, owing to unexplained changes.

During 1911 laboratory tests of lime were continued under the direction of Mr. Emley. Mr. E. S. Young made a progress report on some of the work done during that year at the meeting of the Lime Manufacturers' Association in New York, February 1 and 2, 1912.

Mr. Young's paper as published in advance of the minutes by the association is substantially as follows:[1]

The samples tested consisted of both limes and hydrates procured from manufacturers in different sections of the country. They were sent by express to the laboratory in air-tight jars to prevent air-slaking. The tests applied to these samples were those developed by the lime section of the Bureau of Standards during the last two years, and in brief comprise rate of hydration, color, plasticity, sand-carrying capacity, yield, waste, hardness, crushing and tensile strengths, and shrinkage.

A chemical analysis of each sample was made. This test gives an insight into the purity of the sample and also arranges the samples in classes consisting of dolomitic and high-calcium limes.

The quality of a lime can be determined by slaking it. If either underburned or overburned, it will slake more slowly than if burned at the proper temperature. In order to make this determination, a calorimeter was used. The lime was ground to remove the effect of porosity, and a definite amount of it was added to a definite amount of water. The rise in temperature resulting from the chemical combination of lime and water was observed by reading a thermometer at short intervals of time. In carrying out the other tests, each lime was permitted to slake for twice the time required for the temperature to reach a maximum before being tested.

The amount of lime or hydrate required to give a standard was determined by mixing the sample and water in a suitable can surrounded by cooling water at 25° C. (77° F.). The amount of the water was held constant, and different proportions of the sample were added to it until a standard mixture was obtained—that is, a paste which, when tested by the viscosimeter gave a time factor of 0.6 of a second.

Previously, all limes tested were mixed with sand in the proportion of one lime and three sand. The mortars were brought to the same consistency by changing the proportion of water used. This did not allow for variation in the plasticity or sand-carrying capacity of the limes. It was therefore desirable to devise a test which would determine the proper amount of sand to be added to each lime. A mortar of just sufficient thickness to allow it to be worked into molds was made and tested by the viscosimeter. It was found that the time required to pull the plunger out of the mortar was approximately one second. This factor was then taken as a standard, and all limes and hydrates in the form of a standard paste were mixed with different proportions of standard sand until they gave a time factor of one second when tested in the viscosimeter. The quantities of sand required have been tabulated as part of lime by weight.

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[1] Young, E. S., Testing commercial limes: Bull. Nat. Lime Mfrs. Assoc. No. 5, 1912.

All limes and many hydrates contain some inert material which will not slake during the time allowed for hydration. This inert material is commonly called waste, and was determined by preparing a standard paste and weighing the residue left on a 40-mesh sieve, after washing as much of the sample as possible through the sieve with alcohol. The waste was then calculated as the per cent of the sample.

Yield, or the cubic feet obtained from 1 pound of lime, was calculated from the weight and volume of a sample of standard paste.

Last year a sand blast was used for determining hardness, but this method of testing mortars did not prove practicable. When mortar sets, a coating of carbonate is formed on the outer surface and gradually thickens with time until all the lime has been changed to carbonate. As a rule, these mortars are soft, and the sand blast will easily cut a hole through the specimen or will entirely disintegrate it. Some other means of measuring hardness had to be devised, so the following method was adopted: One thousand grams (2.2 pounds) of BB lead shot were allowed to fall from a reservoir through a 1-inch iron pipe 6 feet 10¾ inches long on a mortar placed on a stand at an angle of 45° with the vertical axis of the pipe. The loss of weight of a mortar due to the impact and wearing action of the shot was found, and was calculated as the percentage loss of the original weight. In the table the figures given for hardness show this percentage loss, and the higher the figure the softer the mortar. There are several objections to this method, and experiments are now being carried on with a different type of instrument, which it is hoped will correct the errors.

Shrinkage and crushing and tensile strengths were made on standard lime mortars. Tensile strength was determined on a sample molded to 1 inch cross sectional area at the center. Crushing strength and shrinkage were made on a 2-inch cube. In the last report of tests, shrinkage was determined on a lime paste. Nearly every paste dried out so quickly that the sample disintegrated. To prevent this, the shrinkage was determined on a mortar by finding the reduction in volume. All samples for these three tests were exposed for one day in a damp atmosphere and were then exposed to the action of the air at room temperature for 90 days.

Color was determined by comparing with a set of standards consisting of calcite with definite amounts of impurities added. The colors run from white to brown. That most nearly white was called No. 1 and the darkest No. 26.

In general, we may say that high-calcium limes will slake faster than dolomitic limes. This is not uniformly true, however, but the discrepancies may be accounted for by the fact that high-calcium limes slake more slowly when underburned or overburned, and indicate the necessity of burning at the proper temperature.

Plasticity, as defined by the dictionary, is that property of a substance which makes it capable of being molded. Limes or similar substances may be divided into three classes, sandy, plastic, and sticky. Sandy substances can be molded with difficulty, appear gritty under the trowel, and are apt to break and leave a pitted surface. They are said to have a low plasticity. Substances that are plastic are easily molded, work smoothly under the trowel, give an even surface, and do not break when finished. They dry out nicely and hold their form. Substances that are sticky can not be readily molded because they tend to stick to the trowel. When they dry out, they are apt to crack badly. Contrary to the dictionary definition, it has become customary with the trade to call these substances too plastic. It appears, therefore, that lime having a high plasticity will not work as well under the trowel as one whose plasticity is intermediate. The plasticity given in the table shows the percentage of lime or hydrate in a standard paste. It follows that a high figure in the table indicates a low plasticity and vice versa. The percentage of lime or hydrate varies according to the kind of lime, whether dolomitic or high calcium, and according to the condition of the lime. Air slaking and underburning or overburning have a decided influence on the percentage of lime required to make a standard paste. If neither underburning nor overburning has influenced the lime, the percentage of high-calcium lime required for a standard paste is lower than that of a magnesian lime. High-calcium limes may therefore be said to have a higher plasticity than dolomitic limes. However, from the data at hand, no marked line can be drawn to separate the two kinds of lime. Both kinds of hydrates show the same average plasticity, although the high-calcium hydrates are generally more plastic.

Weight for weight, high-calcium limes will carry more sand than dolomitic limes on account of their greater volume, as shown by the accompanying tables. Both kinds of hydrates, however, average about the same sand-carrying capacity.

The color of limes or hydrates is a physical or chemical characteristic of the stone as originally found in nature. For building work color is not very important, but in finishing work on walls it has a decided influence.

If lime is underburned, it will contain small particles of limestone, and if it is overburned there are two general conditions which will tend to give waste. If a lime contains many impurities and the temperature of burning is high enough, these impurities tend to flux with the calcium, forming salts which slake very slowly. Under the ordinary conditions of slaking lime, these salts will not be greatly affected and will, if the particles are large enough, be retained by the sieve. Under the ordinary conditions of burning lime the stone calcines at a temperature above that at which magnesium carbonate decomposes. Therefore, the magnesia will generally be overburned. If sufficient quantities of magnesia are present, calcium oxide may be coated by it in the same manner as it is coated with impurities. Now, if water be added to calcium oxide thus covered, it may not slake under ordinary conditions and may form another source of waste. Probably for this reason, among others, magnesian limes slake slower than high-calcium limes. Hydrates that are properly screened should contain little waste.

High-calcium limes require more water for slaking than dolomitic limes and show a larger yield. Also high-calcium hydrates give a larger yield than dolomitic hydrates.

As pointed out before, the test for hardness has not proved very satisfactory, but it may be stated that magnesian limes show superior resisting qualities and are less affected by the shot.

High-calcium limes are distinguished from dolomitic limes by their content of varying proportions of magnesia. When water is added it enters into chemical combination with the lime but has little, if any, effect on the magnesia. On setting, carbon dioxide from the air replaces the water combined with the lime, forming calcium carbonate. It also combines with the magnesia, but probably at a much slower rate. At the end of 90 days, under the conditions of the experiment, the high-calcium limes were probably almost completely carbonated, but the magnesia of the dolomitic limes was not. On the addition of water to any lime there is expansion in volume, but the volume will decrease when the paste dries out. When carbonation starts the volume again increases, but to a less degree. If the volume is constant when complete carbonation has resulted, then, since the magnesian limes have not completely carbonated, or perhaps not even hydrated, the magnesian limes would show a larger shrinkage than the high-calcium limes. Experiments have shown this to be true, as may be seen by referring to the tables. Shrinkage is important because if the mortar is too thin it will dry out too rapidly and the plaster will crack. Some 2-inch cubes have shrunk one-sixteenth inch.

Dolomitic mortars show greater strength, both in compression and tension, than high-calcium mortars, a fact that corroborates the results reported on mortars consisting of a mixture of one part lime by weight and three parts sand, when 6 months old.

Average properties of lime.

CHEMICAL ANALYSIS.

Kind of lime.	Number of samples.	Impurities.	Calcium carbonate.	Calcium hydrate.	Calcium oxide.	Magnesium hydrate.	Magnesium oxide.	Water.	Rate of hydration.
High-calcium lime.	8	2.46	1.68	6.48	88.58	....	1.00	....	25¼
Magnesium lime	4	1.86	3.39	7.92	63.16	....	23.99	....	28
High-calcium hydrate	10	2.33	4.88	89.70	.53	1.22	.67	0.84	....
Magnesium hydrate	8	3.43	5.66	55.78	.33	7.56	24.43	.85	....

PROPERTIES.

Kind of lime.	Plasticity.	Sand-carrying capacity.	Color.	Yield.	Waste.	Hardness.	Crushing strength.	Tensile strength.	Shrinkage.
High-calcium lime	24¾	4¼	16	0.0350	1.39	4.92	....	....	....
Magnesium lime	36½	3	18	.0350	5.23	....	....	....	....
High-calcium hydrate	52½	2½	17	.0225	.30	5.31	144	39	4.32
Magnesium hydrate	52½	2½	14	.0210	1.91	2.16	374	82	6.48

QUALITY OF LIMESTONE.

In his paper on the manufacture of lime, soon to be published, Mr. Emley discusses the quality of limestone essentially as follows:

The art of burning lime may be defined as the process of converting limestone into lime through the agency of heat. The term limestone is used to describe a class of rocks varying in composition from pure calcium carbonate to a mixture of 54.35 per cent calcium carbonate with 45.65 per cent magnesium carbonate, when the material is called dolomite. Any gradation between these limits may be found, and all limestones contain more or less impurities. In the same way, lime may vary from pure calcium oxide to a mixture of calcium and magnesium oxides in the corresponding proportions. The accompanying impurities may or may not be removed. Consequently, the problem of burning lime is merely one of removing the carbon dioxide from the stone by means of heat. When the stone is raised to a sufficiently high temperature and kept there for a sufficient length of time, the carbonates are dissociated and the carbon dioxide is given off as gas, according to the following reactions:

Limestone ($CaCO_3$)+heat=lime (CaO)+carbon dioxide (CO_2), or dolomite ($CaCO_3.MgCO_3$)+heat=magnesian lime ($CaO.MgO$)+2 carbon dioxide ($2CO_2$).

The quality of limestone suitable for burning may vary, both chemically and physically, within rather wide limits.[1] * * *.

The chemical composition of a lime depends on that of the stone from which it was made. Consequently, only those limestones may be used from which a marketable lime can be produced. It must be remembered that on account of the loss of about half the weight of the stone as carbon dioxide, during the burning, the proportion of every other constituent of the stone will be nearly doubled in the lime. The composition which a lime should have for any given purpose is a much mooted question. but a few generalizations may be given.

The demand of the trade would indicate that the amount of impurities (silica and oxides of iron and aluminum) permissible in a finishing lime is very small—certainly not over 5 per cent (2.5 per cent in the stone). Especially should the proportion of iron be very low, on account of its tendency to color the lime red or yellow. The value of lime in chemical industries depends on the amount of the active constituent. Therefore, the impurities act merely as diluents, and for many purposes their presence in rather large amounts is not harmful. The same reasoning applies also to lime used for fertilizer. For building purposes, it is probable that a small proportion of impurities improves the quality of the lime. The Bureau of Standards has attempted to study the effects of various impurities in lime, and, while the results are not sufficiently complete to warrant definite statements, the following general conclusions may be drawn: The presence of small amounts of silica tends to increase the plasticity, sand-carrying capacity, and yield of lime, but has no apparent effect on its hardness or strength. The same may be said of iron, except that large amounts (25 per cent) give a marked increase in both strength and hardness. Alumina increases all of the factors above mentioned and also improves the color, so that its presence even in large amounts is very desirable. On the contrary, gypsum shows detrimental effects, even when only 1 per cent is present. Kaolin seems to act in a manner similar to silica and iron.

The majority of consumers seem to prefer a magnesium to a high calcium lime for finishing purposes, although both kinds are used. These conditions are reversed in the demand for building lime. In the chemical industries the proportions of calcium and magnesium depend entirely on the particular use of the lime, but most industries demand a high-calcium product.

Calcium and magnesium oxides play an important but a distinct part as fertilizers. The amount of either permissible in a lime to be used for this purpose depends on the condition of the soil and the kind of crop, and must be varied to suit each particular case.

Thus it is seen that the presence of a rather large amount of impurities in the stone is permissible, except where a finishing lime or a particular grade of chemical lime is to be made. The ratio of calcium to magnesium desired depends largely on the market in the particular locality. When the lime is sold for chemical purposes this ratio wil generally be specified.

The chemical composition of the stone influences the cost of burning. Experience has shown that it generally requires less heat and a lower temperature to burn a magnesium than a high-calcium stone. The greater the proportion of impuritie the more easily is the lime overburned, and therefore too large an amount of these constituents will cause a diminution of the capacity of the kiln. It is possible that the proportion of silica may be high enough to form the dicalcium silicate—2 $CaO.SiO_2$. This substance when cooled slowly assumes allotropic forms. Thus at 675° C. it changes from the α to the β modification with a marked increase in volume.[1] This causes the lime to fall to pieces, a phenomenon commonly known as "fire slaking."

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[1] Chemical analyses of many types of limestone are given on pp. 16–65.

From the chemical analyses of the samples of stone collected during this investigation it will be seen that the amount of lime varies from 29.77 per cent to 55.56 per cent, and of magnesia from 0.31 per cent to 21.23 per cent, but that the total quantity of combined carbonates in any stone is never much less than 97 per cent. The silica is occasionally somewhat over 2 per cent without injury to the stone for lime burning, but the alumina and oxide of iron are generally under 0.5 per cent. It must be remembered, however, that this investigation did not cover the entire field, and that imes are being produced in which the proportion of impurities is so high that they are practically natural cements.

So far as its physical properties are concerned, any kind of limestone is suitable for burning. These properties do, however, influence to a noticeable extent the cost of production. Experience has shown that a fine-grained dense stone can be burned at a lower temperature and with less heat than one that is coarsely crystalline and porous. Coarsely crystalline stones, especially if they are very pure, are apt to fall to pieces in the kiln, thus reducing the production of lump lime. The same occurrence s sometimes noticed when a porous stone is used, although in this case it is probably due to the rapid expulsion of water from the pores. On the other hand, laboratory work done during this investigation indicates that "all naturally porous stones lost their carbon dioxide at a lower temperature (1652° F.) than the denser materials." [2] Why these laboratory results are contradicted in practice is a subject for future investigation, and is probably dependent on the size of the pieces of stone, the quantity of material used, and similar factors.

Whether a limestone is porous or not, its water content is important, for this water must be evaporated, with consequent loss of heat and lowering of kiln efficiency. Moreover, some of the water, in chemical combination with the clayey impurities of the stone, will probably not be given off until the stone has reached a red heat. This will require the stone to remain in the burning zone for a longer time, and may therefore to some extent reduce the kiln capacity.

LIME BURNING.

From the same unpublished paper by Mr. Emley the following comments on lime burning are taken:

Three factors are essential to the process of lime burning: (1) The stone must be heated to the temperature of dissociation of the carbonates, (2) this temperature must be maintained for a certain length of time, (3) the carbon dioxide evolved must be removed.

Many experiments have been made to determine the temperature of dissociation of calcium carbonate. The best and most recent work done on this subject is probably that by Johnston,[3] who established the dissociation temperature at 898° C. (1,648° F.). The corresponding temperature for magnesium carbonate is generally given as 550° C. (1,022° F.). There is some doubt, however, as to whether magnesium carbonate exists n limestone as such or whether it is combined with calcium carbonate to form the double salt dolomite. If the latter be true the dolomite may have a different dissociation temperature, which has not been determined.

After this temperature has been reached it must be maintained for some time in order to transfer the required amount of heat to the stone. Johnston, quoting from Thomson, gives the heat of dissociation of calcium carbonate as 42,900 calories per gram molecule at 300° Abs. Assuming a rate of variation of this factor with the temperature, he calculates the figure to be 38,500 calories at 1,100° Abs. Since the heat of dissociation of calcium carbonate at the temperature ordinarily used in practice has never been determined, it can not be stated that the figures given are scientifically accurate, and the same inaccuracy of our knowledge applies with regard to magnesium carbonate. In the discussion of the heat efficiency of lime kilns, we have assumed these figures to be 768.55 B. t. u. per pound for calcium carbonate, and 464.3 B. t. u. per pound for magnesium carbonate admitting that these figures are not accurate but claiming in their defense that they are probably sufficiently near the truth for practical purposes.

The physical properties of the stone undoubtedly have some influence on the amount of the heat required and the time in which this heat can be transferred at any given temperature. Thus it will take longer to burn a large piece of stone than a smaller one. A fine-grained, dense stone will conduct the heat more readily than one which is coarsely crystalline and porous. Practical experience seems to point to the fact that the crystals themselves require more heat to dissociate them than the amorphous stone. The time required to transfer a given amount of heat roughly speaking varies inversely with the temperature difference. Therefore it has been found economical to use as high a temperature as possible in order to reduce the time required for burning. The upper limit of the temperature is determined by the phenomenon of "overburning." Overburned lime can be recognized by its yellow color and by the extremely long time it takes to slake. These features or properties are probably caused by a chemical combination of the lime with the impurities (especially with the silica and silicates) it contains. This is indicated by the fact that it has been found practically impossible to overburn some limes, which are exceptionally pure. Lime may be overburned by being heated for too long a time, as well as by being heated to too high a temperature. In general it is better to underburn than overburn lime, for the unburned stone may be put back into the kiln, while the overburned lime is useless. Moreover, the properties of overburning seem to assert themselves gradually, so that the best lime is obtained by using the minimum amount of heat.

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[1] Day, A. L., and Shepherd, E. S., The lime-silica series of minerals: Jour. Am. Chem. Soc., 1906, p. 1089.

[2] Bleininger and Emley, Burning temperatures of limestone; Trans. Nat. Lime Mfrs. Assoc., 1911, p. 77.

[3] Johnston, Thermal dissociation of $CaCO_3$; Jour. Am. Chem. Soc., August, 1910, p. 938.

To summarize: A certain quantity of heat must be supplied to dissociate the carbonates in the stone. The quantity varies with the chemical and physical properties of the stone. In supplying this heat it is optional to use either a high temperature for a short time or a lower temperature for a longer time. The temperature reached must be higher than 898° C. (1,648° F.), if decomposition is to take place at atmospheric pressure. The more nearly the amount of heat used approaches the minimum required, the better will be the quality of the lime.

It is well known that the chemical reaction involved in burning lime is reversible. That is, calcium carbonate may be decomposed into calcium oxide and carbon dioxide, or these substances may recombine to form calcium carbonate. The factor which determines the way the reaction shall go is the pressure of the carbon dioxide.[1] If this gas is removed as formed, so that its partial pressure is kept below that given for the temperature by Johnson's equation, the reaction will continue in the direction to form lime. But if the gas is allowed to accumulate until its pressure becomes higher than this, the reaction will be reversed and will give rise to the phenomenon known technically as "recarbonating." Therefore the prompt removal of the gas is an essential operation in lime burning.

PUBLICATIONS.

Owing to the interest shown by correspondents of the Survey in the lime industry and to the fact that the Survey has heretofore been unable to give to this subject the attention it merits, a partial list of the more important recent publications, covering a wide range of topics, is given below. These publications naturally fall into two groups: (1) On raw materials, and (2) on the manufacture, properties, kinds, and uses of lime. High-calcium limestone that is suitable for the manufacture of Portland cement is generally suitable for the manufacture of lime, and elsewhere in the volume Mineral Resources for 1911 is given a more complete list of publications by State and United States geological surveys on limestones available for making cement.

The United States Geological Survey distributes its own publications only. For State publications applications should be made to the State geologists, and private publications should be obtained direct from the publishers.

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[1] Bleininger, A. V., Trans. Am. Ceramic Soc., vol. 9, 1907, p. 454.

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EORGIA: McCallie, S. W., Marbles of Georgia: Bull. Georgia Geol. Survey No. 1, 2d ed., 1907, 126 pp.

LLINOIS: Udden, J., and Todd, J. E., Structural materials in Illinois: Bull. Illinois State Geol. Survey No. 16, 1910, pp. 342–390.

OWA: Beyer, S. W., and Williams, Ira A., The geology of quarry products: Iowa Geol. Survey, vol. 17, 1906, pp. 187–584.

AINE: Bastin, E. S., The lime industry of Knox County, Me.: Bull. U. S. Geol. Survey No. 285, 1906, pp. 393–400.

ARYLAND: Mathews, E. B., and Grasty, J. S., The limestones of Maryland, with special reference to their use in the manufacture of lime and cement: Maryland Geol. Survey, vol. 8, pt. 3, 1910, pp. 225–484, 14 pls., map.

ISSOURI: Buehler, A. H., Lime and cement resources of Missouri: Missouri Geol. Survey, vol. 6, 2d ser., 1907, 255 pp.

EW JERSEY: Kümmel, H. B., The chemical composition of the white crystalline limestones of Sussex and Warren Counties: Ann. Rept. New Jersey State Geologist for 1905, pp. 173–192.

EW YORK: Ries, H., Lime and cement industries of New York: Bull. New York State Mus. No. 44, 1903, pp. 640–848.

HIO: Orton, E., jr., and Peppel, S. V., The limestone resources and the lime industry in Ohio: Bull. Ohio Geol. Survey No. 4, 4th ser., 1906.

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HILIPPINE ISLANDS: Adams, George I., Mineral resources of southwestern Luzon: Min. World, Sept. 10, 1910, pp. 463–465.

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Warner, Irving, Glossary of terms: Mason Builder, September, 1910, p. 142; October, 1910, p. 158. See also Trans. Nat. Lime Mfrs. Assoc., 1910, pp. 14–24.

Eckel, E. C., Burchard, E. F., and others, Portland cement materials and industry in the United States: Bull. U. S. Geol. Survey No. 522, 1912. (In press.)

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leininger, A. V., and Emley, W. E., The burning temperature of limestones: Trans. Am. Ceramic. Soc., vol. 13, 1911, pp. 618–638.

raham, J. B., Lime as a fertilizer: Rock Products, vol. 9, No. 10, Apr. 22, 1910, pp. 33.

riffith, R. W., The use of lime in tanneries: Rock Products, Sept. 22, 1911, p. 36.

cCullough, Ernest, Methods of manufacturing hydrated lime: Mining World, Dec. 3, 1910, pp. 1049–1050.

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agel, Oscar, Gas firing for lime and cement kilns: Cassiers Mag., September, 1909, pp. 408–419.

ransactions of the National Lime Manufacturers' Association:

1909: Bachtenkircher, H. E., The hydration problem to date, 1909, pp. 337–340.

Bleininger, A. V., The physical properties of lime, pp. 365–369.

Hunkins, D. S., Development of limekiln construction in the Middle West, pp. 345–351.

Lazell, E. W., The standardization of hydrated lime, pp. 361–365.

Peppel, S. V., Heat temperatures in limekilns as related to the fuel problem, pp. 370–377.

Spencer, A. N., A study of the limekiln lining problem, pp. 351–359.

Wall, Edward E., The use of lime for water purification at St. Louis, Mo., pp. 330–337.

Wing, Charles B., The necessity of lime in growing alfalfa, pp. 377–379.

Transactions of the National Lime Manufacturers' Association—Continued.

1910: Anon., Classification of lime for agricultural purposes, pp. 7–8.

——— Glossary of terms in connection with manufacture of lime, pp. 14–24.

Ashley, Harrison Everett, The spreading and setting properties of lime mortars, pp. 43–47.

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Broomell, A. P., The modern limekiln, pp. 66–69.

Emley, Warren E., Kiln design, pp. 90–107.

——— Some investigations on lime, pp. 48–50.

Fippin, Elmer O., The relation of lime to soil improvement, pp. 78–89.

Gawthrop, H. A., How should the modern kiln be constructed, pp. 28–37.

Schmatolla, E., Producer-gas fired lime plants, pp. 108–112. See also Chem. Eng., March, 1910, pp. 73–76.

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Spackman, Henry S., The possible effect of Alca lime plasters and cements on the future of the lime trade, pp. 6–12.

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Whyte, G. W., The theory and phenomena of the gas producer as a piece of apparatus, and as applied to the limekiln, pp. 94–106.

Wig, Rudolph J., The use of hydrated lime in Portland cement mixtures, pp. 213–220.

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4. Is the recommendation that only ground limestone should be used for agricultural purposes a sound and rational one?
5. Testing commercial lines.
9. Natural draft and natural pressure explained.
10. The target of lime-cost reduction.
11. A study of several types of lime kilns.
12. Review of the year's work in the development of Alca lime.
18. Plant foods.
19. The manufacture and properties of hydrated line.
20. Sweetening the soil.
21. Raising grain.
22. Texture of soil.
23. Lime on the farm.
26. Hydrated lime.

SAND-LIME BRICK.

INTRODUCTION.

The sand-lime brick industry in 1911, as indicated by the figures which follow, showed a considerable decrease in value compared with previous years. The value of the production reported in 1911 was $897,664, compared with $1,169,153 in 1910, a decrease of $271,489, or 23.22 per cent. In fact the value of the products in 1911 was the smallest reported since 1904, and was 26.77 per cent less than the maximum of 1907. The number of operating firms reporting was also the lowest since 1904; it was 66, or 28 less than reported in 1907 and 10 less than in 1910.

PRODUCTION.

The following table shows the production of sand-lime brick in the United States from 1903 to 1911, inclusive:

Value of production of sand-lime brick in the United States, 1903–1911.

Year.	Number of firms reporting.	Value of product.	Year.	Number of firms reporting.	Value of product.
903	16	$155,040	1908	87	$1,029,699
904	57	463,128	1909	74	1,150,580
905	84	972,064	1910	76	1,169,153
906	87	1,170,005	1911	66	897,664
907	94	1,225,769			

This table shows that the value of sand-lime brick rose rapidly until 907, the year of maximum value of production and also of the argest number of operating firms. In 1908 there was a decrease of 196,070, or 16 per cent; in 1909 and 1910 there were slight increases; but in 1911 the lowest value was reached ($897,664) since 1904.

The following tables show the production of sand-lime brick in 1910 and 1911 by States and kinds:

Production of sand-lime brick in the United States in 1910, by States and kinds.

State.	Number of operating firms reporting.	Common brick.		Front brick.		Fancy brick.		Miscellaneous, value.[a]	Total value.
		Quantity (thousands).	Value.	Quantity (thousands).	Value.	Quantity (thousands).	Value.		
California	5	3,094	$27,368	1,097	$16,144	....	....	....	$43,512
Colorado, Idaho, Montana, and Washington	6	5,786	52,724	2,676	38,054	105	$3,757	....	94,535
Delaware, District of Columbia, Maryland, North Carolina, and Virginia	7	3,224	25,751	(b)	(b)	....	....	(b)	42,455
Florida	4	12,685	77,950	(b)	(b)	....	....	....	85,450
Georgia and Mississippi	3	3,606	20,489	(b)	(b)	....	....	....	24,146
Indiana	5	13,869	63,134	(b)	(b)	....	....	....	63,534
Iowa	3	(b)	(b)	(b)	(b)	(b)	(b)	(b)	31,269
Kansas, Nebraska, North Dakota, South Dakota, and Texas	7	17,440	132,827	831	9,289	....	....	....	142,116
Kentucky and Ohio	3	5,232	32,050	....	....	....	....	....	32,050
Michigan	10	37,648	218,627	(b)	(b)	....	....	....	240,649
Minnesota	5	22,444	145,705	544	7,345	(b)	(b)	....	154,250
New Jersey	3	1,512	9,254	(b)	(b)	(b)	(b)	....	23,811
New York	7	14,647	89,150	....	....	....	....	....	89,150
Pennsylvania	4	11,854	72,827	....	....	....	....	....	72,827
Wisconsin	4	4,426	29,055	(b)	(b)	....	....	....	29,399
Other States[c]	....	3,513	26,906	6,156	52,342	118	4,113	$14,292	(d)
Total	76	160,980	1,023,817	11,304	123,174	223	7,870	14,292	1,169,153
Average price per M	....	....	$6.36	....	$10.90	....	$35.29	....	....

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[a] Including door and window sills and building blocks.
[b] Included in "Other States."
[c] Includes all products made by less than three producers in one State to prevent disclosing individual operations.
[d] The total of "Other States" is distributed among the States to which it belongs in order that they may be fully represented in the totals.

Production of sand-lime brick in the United States in 1911, by States and kinds.

State.	Number of operating firms reporting.	Common brick.		Front brick.		Miscellaneous, value.[a]	Total value.
		Quantity (thousands).	Value.	Quantity (thousands).	Value.		
California	4	(b)	(b)	980	$11,495	....	$19,53
Colorado, Idaho, and Washington	5	3,795	$30,008	613	7,995	....	38,00
Connecticut, District of Columbia, Maryland, Massachusetts, and Pennsylvania	7	12,420	76,808	(b)	(b)	(b)	80,83
Florida	3	9,266	51,266	(b)	(b)	....	56,27
Georgia, Kentucky, Mississippi, and Ohio	5	10,306	59,765	(b)	(b)	....	66,32
Indiana	3	10,192	45,891	....	....	....	45,89
Iowa, Kansas, Nebraska, North Dakota, and Texas	7	8,361	68,994	(b)	(b)	....	73,5
Michigan	10	32,889	192,224	2,726	17,777	....	210,0
Minnesota	4	15,957	89,569	272	4,075	(b)	93,7
New Jersey	3	1,314	8,716	674	8,994	....	17,7
New York	8	15,547	93,980	(b)	(b)	....	95,9
South Dakota	3	4,200	31,535	....	....	....	31,5
Wisconsin	4	10,238	68,312	....	....	....	68,3
Other States[c]	....	1,087	8,040	2,126	20,130	2,090	(d)
Total	66	135,572	825,108	7,391	70,466	2,090	897,6
Average price per M	....	....	6.09	....	9.53	....	....

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[a] Including blocks and trimmings and fancy brick.
[b] Included in "Other States."
[c] Includes all products made by less than three producers in one State to prevent disclosing individu operations.
[d] The total of "Other States" is distributed among the States to which it belongs in order that they m be fully represented in the totals.

The value of the product decreased in 1911, as shown by these ables, $271,489, or 23.22 per cent. In 1910 this product showed an crease over 1909 of $18,573, or 1.61 per cent. The number of tates reporting in 1911 was 26. This is a net decrease of 2, Delaware, ontana, North Carolina, and Virginia dropping out, and Connecticut nd Massachusetts being added as producers. In order to avoid dislosing individual operations, it has been necessary to group certain tates. Michigan in 1911, as from the first, except for 1906, was the eading State in value of output and reported wares valued at $210,001; his was a decrease of $30,648 from 1910, or 12.74 per cent. Michigan's roduct constituted 23.39 per cent of the total value of all sand-lime roducts in 1911, and 20.58 per cent of the total of 1910. New York as second in value of product, displacing Minnesota, which was hird. Wisconsin rose from ninth in 1910 to fourth in 1911.

Of the States for which totals are given, but two showed an inrease—New York and Wisconsin. Of these, Wisconsin showed the arger increase—$38,913, or 132.36 per cent. New York's increase as $6,780, or 7.61 per cent. Minnesota, which showed the largest crease in 1910, showed the largest decrease in 1911, $60,576, or 9.23 per cent.

Michigan continues to have the largest number of operating firms eporting—10 in 1911, the same as in 1910. New York was next with operating firms reporting, an increase of 1. Minnesota showed a ecrease of 1, and Wisconsin reported 4, the same number in both ears.

The average price per thousand for common sand-lime brick was 6.09 in 1911, as compared with $6.36 in 1910 and with $6.39 in 1909; r front brick it was $9.53 in 1911, as against $10.90 in 1910 and 11.98 in 1909. In 1911 common brick yielded 91.92 per cent of the alue of all products; front brick 7.85 per cent, and all other prodcts 0.23 per cent; in 1910 these percentages were 87.57, 10.53, and .90, respectively.

SLATE.

By A. T. Coons.

PRODUCTION.

GENERAL CONDITIONS OF THE INDUSTRY.

In 1911 the output of slate, as reported to the United States Geological Survey, decreased in value $508,740, from $6,236,759 in 1910 to $5,728,019 in 1911. Although this decrease was conspicuously large, the production did not fall below that of the year 1909, when the value was $5,441,418—the smallest value for slate since 1901, when it was $4,787,525.

The statistics of the production of slate, as given in this report, represent the output of slate as reported by the slate quarrymen and include the quantity and value of roofing slate and of mill stock sold by them and the value of a quantity of slate sold for other purposes. The values given for mill stock represent prices f. o. b. at the point of shipment, the mill stock being classed as rough or manufactured, according to the condition in which it is sold by the quarrymen, whether as rough blocks to slate mills or in a finished or partly finished state from mills at the quarries.

The slate operators in general reported unsettled trade conditions for 1911, with demand fair and prices generally lower than in 1910. The decrease in production was in the output both of roofing slate and of mill stock, although mill stock, exclusive of blackboard and school-slate material, increased in value of output. Arkansas, Maine, New Jersey, New York, and Virginia increased in total value of slate output, but not enough to overcome the considerable decreases of Pennsylvania and Vermont. New Jersey, New York, and Virginia were the only States showing increased output of roofing slate, and Maine and Pennsylvania increased in value of mill stock.

In 1911 nine States contributed to the commercial output of slate in the United States. These States, named in rank of output, were Pennsylvania, Vermont, Maine, Virginia, New York, Maryland, New Jersey, Georgia, and Arkansas. In 1910 the producing States ranked as follows: Pennsylvania, Vermont, Maine, Virginia, New York, Mary-and, New Jersey, California, Georgia, and Tennessee. The rank, therefore, remained the same for the principal producing States, but the quarries of California and Tennessee were idle in 1911 and Arkansas reentered the list with a small output of roofing slate.

CLASSIFICATION OF SLATE.

For general purposes slate is classified as mill stock and roofing slate, and the use for these different purposes depends largely, although not entirely, on the character of the slate.

Mill stock.—Mill stock requires a finer, more even-grained and more compact slate than roofing slate, with a smooth cleavage surface. It must be of a fairly uniform color and not too hard to be easily worked by the slate-dressing machinery. The slates of Maine and Vermont and of Lehigh and Northampton counties, Pa., are well adapted for this purpose, and these slates are also among the best of the roofing slates. The Arkansas slate has been used for electrical purposes—although the entire 1911 product was for roofing slate—and the Maryland and New York quarries also furnish mill stock. It is said that much of the slate that goes on the dump from a roofing-slate quarry might be utilized as mill stock, thus lessening somewhat the size of the dumps that are so detrimental to the successful operation of a slate quarry.

The value of mill stock, including slate sold for all purposes other than roofing, decreased from $1,392,095 in 1910 to $1,379,448 in 1911, a decline of $12,647. Exclusive of blackboard and school slates, the mill stock increased from 5,181,498 square feet, valued at $999,098, in 1910, to 5,744,577 square feet, valued at $1,027,605, in 1911, an increase of 563,079 square feet in quantity and of $28,507 in value. The average price per square foot was 18 cents in 1911 and 19 cents in 1910. The greater part of the slate was either entirely milled by the producer or sold to other mills in a partly milled state.

Mill stock includes blackboards, school slates, flooring, wainscoting, vats, tiles, sinks, laundry tubs, grave vaults, sanitary ware, refrigerator shelves, flour bins and dough troughs for bakeries, electrical switchboards, mantels, hearths, well caps, and billiard, laboratory, kitchen, and other table tops. This material is made in the form of slabs, from 1 inch to 3 inches or more thick, and is sold at prices ranging from 4 cents to 50 cents per square foot, according to the size, thickness, and quality of the slate and to the work done on it. It is sold in rough slabs by the quarrymen to the slate mills, or is milled by quarrymen operating their own mills.

It is noteworthy that quarries in Lehigh and Northampton counties, Pa., report the only stock produced for school slates and blackboards. These quarries can best produce this material on accoun of the unusually fine cleavage of their slate and the thickness an size of the beds. The quantity and value of the slate produced fo these uses decreased in 1911.

Roofing slate.—Slate used for roofing is not necessarily of so fin a texture nor with so smooth a cleavage as the mill stock, but i must be hard, strong, and tough, and should not contain minerals such as carbonates, iron pyrites, etc., which decompose or oxidiz under atmospheric conditions. The color should be uniform an free from streaks, and although the slate may fade somewhat upo exposure, it is not undesirable unless it weathers mottled, owing t irregular distributions of the coloring matter, and thus produces a unsightly roof. A description of the process of dressing roofin slates is given by Eckel,[1] who says:

> Roofing slates pass through three operations—block making, splitting, and dressing before they are ready for the market. At times they are further subjected to punc ing or to countersinking, according to the requirements of the purchaser. All these operations were formerly carried on by hand, and at most small quarries and so large ones hand labor is still depended on for most of the work. Some of the ope tions can, however, be done more economically by machinery.

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[1] Eckel, E. C., Building stones and clays, their origin, character, and examination. John Wiley & So New York, 1912.

The slate is hoisted from the quarry in slabs which average perhaps 6 feet by 3 feet by 1½ feet. When hand dressing is depended on, these slabs are loaded on a tram car and pushed to dressing sheds, a series of little sheds or cabins each occupied by a dressing gang. A dressing gang includes three men—a block maker, a splitter, and a dresser. Ordinarily each gang takes contracts from the company at a fixed price per square of finished slate, the receipts being divided by the three members of the gang in fairly equal proportions, though the dresser or trimmer usually gets a little less than the other two. The work is divided and carried on as follows: The block maker takes the large slabs or blocks above noted and cuts them into manageable slabs about 2 feet by 1½ feet in size and 2 inches thick. This is done with the chisel. In making the cut across the grain the operation is called "sculping," which consists in first cutting a V-shaped notch in one side of the slab with the gouge, after which the splitting chisel is held with edge vertical in this notch and struck with the hammer. The slab is now passed on to the splitter, whose special tool is the thin splitting chisel, 10 to 15 inches long, and with an edge 2 to 3½ broad. One or more of these are driven into the slate, along some cleavage plane, with the maul, and are then worked backward and forward by hand until the slate splits. The splitting is continued until the slates are reduced to the proper thickness, which may be from one-eighth to one-fourth inch. The slates, now of proper and uniform thickness but of irregular shapes, are given to the dresser or trimmer, who formerly trimmed them to size with a knife. At present hand or foot power dressing machines are employed everywhere, the general design being a long knife, set vertically and hinged at one end, while the other end is alternately raised and lowered by hand or by a treadle.

At a large Pennsylvania quarry the slate blocks were delivered by the company in front of the dressing sheds, and tools were furnished and sharpened at company expense, while the dressing gang received the following prices per square of finished slate:

No. 1 quality	$1.10
Intermediate quality	1.00
No. 2 quality	.90

It has been noted that machine work is now employed for some of these operations. Splitting is still done by hand labor, as mechanical splitters have rarely given good results. The blocks, however, are usually given at least one sawed edge before being handed to the splitter, this being done on a sawing table with vertical saw, such as is used in preparing millstock.

The thickness of a roofing slate varies usually with the size of the slate, decreasing with its area.

Slates are graded according to their smoothness of surface, even thickness, and (in some districts) uniformity of color. Usually two grades will cover the output of any given quarry, but occasionally a third grade is employed.

Roofing slates are always cut so that the longer sides of the slate are in the direction of the grain. This is done not only to secure ease of dressing, but to give additional security for slate roofs. If a slate so cut be broken while on the roof, the fracture will be in the direction of the grain, and the two fragments of the slate will still be held by single nails; while if the slate had been cut in the opposite direction (that is, longer sides across the grain) the lower part of a broken slate would have nothing to hold it on the roof.

Two different units of measurement are employed in the slate-roofing trade, the square and the mille, the former being used at all American quarries, while the latter is found in French and English markets.

The mille, which is a unit much used in Europe, is nominally 1,200 slates of any given size. As slates are shipped at the purchaser's risk, however, 60 slates are added to cover breakage, so that the actual mille contains 1,260 slates. The number of squares in a mille will of course vary according to the size of the slate.

The "square," the United States unit of measurement, is a sufficient number of pieces of slate of any size to cover 100 square feet of roof, with allowance generally for a 3-inch lap. The size of the pieces of slate making up a square ranges from 7 by 9 inches to 16 by 24 inches, and the number of pieces in a square ranges from 85 to 686, according to the size of the pieces. The ordinary thickness of a piece is from one-eighth to three-sixteenths of an inch, and the approximate weight per square is about 650 pounds. The slate is generally shipped in carload lots, each lot consisting of 50 to 100 squares, according to the size of the pieces.

The price per square for ordinary slate of No. 1 quality ranges from $3.50 to $10 per square f. o. b. at the quarries, and depends on the color, size, thickness, smoothness, straightness, and uniformity of the pieces. Specially prepared slate, with pieces carefully selected with regard to color, quality, extra thickness and size, and extra cutting, commands from $30 to $200 per square. For ordinary slate the red slates of New York command the highest prices. The red slates of New York and the green slates of Vermont are the kinds generally prepared for special work.

About 76 per cent of the value of the slate production in the United States in 1911 was represented by slate for roofing; and the roofing-slate output from Pennsylvania and Vermont represented, respectively, about 58 and 31 per cent of the total value of roofing-slate output. Besides roofing slate, Pennsylvania and Vermont produce also mill stock; practically the only use of slate from the other producing States, except Maine, is for roofing.

In 1911 the output of roofing slate was reported as 1,124,677 squares, valued at $4,348,571, the average price per square being $3.87; in 1910 there were reported 1,260,621 squares, valued at $4,844,664, with an average price per square of $3.84, a decrease in 1911 of 135,944 squares in quantity and of $496,093 in value, but an increase of 3 cents in price per square.

COLOR OF SLATE.

As the color has considerable effect on the marketing of slate it may be of interest to the slate trade to have in condensed form the following brief description of the slates from different localities. Of course the color value given to a slate varies with the color sense of the person interested, but as the colors were mostly reported by the quarrymen themselves, they probably represent the color by which the different slates are known to the trade. However, it is very probable that in the description the same locality is represented more than once, as, for example, the slate for Sussex County, N. J., is given both as "black" slate and as "blue" slate.

Description of slates by color, by localities.

- Black, including brilliant black, blue-black, gray-black, jet-black, and dark blue black:
    - Arkansas: Montgomery and Polk counties.
    - California: Eldorado County.
    - Colorado: Gunnison County.
    - Georgia: Polk County.
    - Maine: Piscataquis and Somerset counties.
    - Maryland: Harford County.
    - Nevada: Humboldt County.
    - New Jersey: Sussex County.
    - New York: Washington County.
    - Pennsylvania: Lehigh, Northampton, and York counties.
    - Virginia: Buckingham County.
- Blue, including dark-blue, unfading blue, gray-blue:
    - Arizona: Maricopa County.
    - Georgia: Polk County.
    - New Jersey: Sussex County.
    - Pennsylvania: Lehigh and Northampton counties.
    - Virginia: Albermarle and Buckingham counties.
- Gray, including light-gray, bluish-gray, greenish-gray:
    - Arkansas: Montgomery and Polk counties.
    - Vermont: Rutland County.

- Dark-gray, including dark bluish-gray.
  - Arkansas: Montgomery and Polk counties.
  - Colorado: Gunnison County.
  - Maine: Piscataquis County.
  - Pennsylvania: Carbon, Dauphin, and Northampton counties.
  - Vermont: Washington County.
  - Virginia: Amherst and Buckingham counties.
- Green, including mottled, sea green, unfading green, and variegated green:
  - Arkansas: Montgomery and Polk counties.
  - California: Eldorado County.
  - Georgia: Bartow County.
  - New York: Washington County.
  - Utah: Utah County.
  - Virginia: Albemarle County.
  - Vermont: Rutland County.
- Purple, including mottled purple, chocolate purple, variegated, light and dark purple:
  - Maryland: Frederick County.
  - New York: Washington County.
  - Utah: Utah County.
  - Vermont: Rutland County.
- Red:
  - Arkansas: Montgomery and Polk counties.
  - New York: Washington County.
  - Utah: Utah County.
  - Vermont: Rutland County.
- Variegated, including purple, green, red, pink, etc.:
  - New York: Washington County.
  - Vermont: Rutland County.

In this connection the following statements on the origin of slates and the reason for the color in them, by Dale and Eckel, are of interest. Dale[1] says:

> With the exception of the rare slates of igneous origin, slates originate in marine deposits of clay and sand. The common occurrence of angular grains of feldspar and of quartz in slate implies the nearness of shores or land masses of granitic rocks to such deposits. The alternation of beds of slate with beds of quartzite or grit ("ribbons," "hards," altered sandstone) corresponds to the alternation of extremely fine clayey sediments, derived from the waste of granitic land masses, with sandy sediments consisting of coarser material from the same source. The repeated alternation of such fine and coarse sediments is attributed to the alternation of calm water, favorable to the deposition of fine material, with strong currents that bring coarse sediments more rapidly from the shore. These materials consisted largely of quartz, feldspar, and mica, but included also zircon and other silicates, various compounds of iron, lime, and magnesia, as well as kaolin arising from the decomposition of the feldspar. In such a slate region as that of western Vermont and eastern New York, where the slate is interbedded with fossiliferous limestone, it is evident that alternating with such changing conditions in the water there were also periods when marine life abounded and the sediments were entirely calcareous. Black slates owe their blackness to carbonaceous matter, probably derived from the decomposition of marine organisms on the sea floor. Red slates owe their color to the access of ferruginous matter from the land, and purplish ones to an admixture of this and a green magnesian mineral (chlorite) of secondary origin. In both the reddish and purplish slates the iron is supposed to have been originally precipitated in the form of the rust-colored limonite ($2Fe2O_33H_2O$) from iron-bearing solutions, and afterwards altered by loss of water (H_2O) to the reddish hematite (Fe_2O_3).

Eckel[2] says:

> Slates from various districts, and in some cases even from different parts of the same quarry, show very marked differences in color. The commonest colors are various shades of gray and bluish-gray. Black is probably the next most abundant

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[1] Dale, T. N., and others, Slate deposits and slate industry of the United States: Bull. U. S. Geol. Survey No. 275, 1906, pp. 6–7.

[2] Eckel, E. C., Building stones and clays, their origin, characters, and examination. John Wiley & Sons, New York, 1912, pp. 108–110.

color, followed in turn by reds of various shades. Greens are less common, especially the purer and clearer greens, though grayish-green is not rare. Purple is perhaps the scarcest of the colors in which slate is found. Yellow, brown, and buff slates occur, but these colors are invariably due to weathering and though showing at the surface do not occur in the merchantable slate.

In almost all cases the colors shown by slates are due to the amount and condition of two of the constituents of the slate—organic matter and iron oxides. It may be fairly assumed that the normal or average slate color is some shade of gray. If the slate contains considerable finely divided carbonaceous matter, it will probably show a glossy black color on its cleavage surfaces. If it is high in ferric iron, it will probably be a red or purple slate. If the iron is in the ferrous form, the slate will normally be green, if fairly free from organic matter; and black, if organic carbon is present in addition to the ferrous iron.

The color of slate is of importance industrially in so far as it affects the physical properties, the permanence, and the salability of the product.

So far as strength is concerned, there is little to choose between the various colors. The glossy black slates are, on the average, apt to be somewhat finer grained, somewhat softer, and considerably more smooth and even grained than those of any other color. The gray slates, on the other hand, usually are at the other extreme of the series in all of these respects; while the red and green slates are intermediate. The properties in which the black slates excel are obviously those which fit them well for mill stock, while they are negative or actually harmful so far as strength and durability are concerned.

In regard to the permanence of color throughout long exposure to the weather, which is a matter of importance in the selection of roofing slates, slates may be either practically permanent in tint, they may fade evenly and slightly, or they may fade or discolor in uneven patches. Except for the difficulty in matching the tint when a few slates on a roof require replacement, there would be no objection to a moderate and even fading, while of course a slate which changes color in blotches is highly objectionable. So far as original color affects these matters, it may be said that the black and gray slates are commonly either entirely permanent in color or show but slight changes; that the bluish slates often turn more grayish, while most red slates take on a browner tint. The green slates are the most doubtful always, for while some of them are practically permanent in color, others discolor badly. The change in color of the fading green slates is due, according to Dale and Hillebrand, to the presence of small quantities of unstable iron-lime-magnesia carbonates, in which the ferrous iron gradually oxdizes and hydrates to limonite. The development of discoloring blotches in slate of any tint is generally due either to the same cause or to the weathering of small grains of iron sulphide (pyrite or marcasite).

The salability of slate is largely influenced by color. As the entire slate trade is governed by tradition, it being in this respect perhaps the most archaic of existing industries, it is very difficult to introduce a new slate, and particularly so if its color differs from that to which the particular local market is accustomed. When a new company attempts to do this, its competitors never have the slightest difficulty in producing a hundred ancient Welshmen who are willing to swear that in all the years since Wales first rose above the sea no one has appeared mad enough to even suggest using a slate of that particular tint for roofing purposes. It is only recently that the slate trade has thought of submitting such matters to laboratory tests, in place of relying on the traditional lore of the bards.

There is a very definite advantage to a slate company arising from the control of two or more colors of slate, whether these are taken from the same quarry or from entirely different districts. Architects usually specify color as well as grade, and a company which can supply only one good color or type of slate must necessarily lose a good deal of desirable business. A good example of the advantage of controlling two well-contrasting colors is afforded by a western company whose quarry is in a glossy black slate, but with a few narrow bands of green slate. The latter is marketed for lettering and ornamental work on the black slate background, and the idea has taken very satisfactorily. In the Eastern States the slate industry seems to be on the verge of developing on a larger scale than heretofore, and doubtless this development will ultimately take the form of large companies, each owning a number of quarries in different districts, so that each can supply slate of any specified grade and color.

QUANTITIES AND VALUES.

The following table shows the quantity and the value of roofing, mill, and other slate quarried in the United States in 1910 and 1911, by States and uses:

Quantity and value of roofing, mill, and other slate produced in the United States in 1910 and 1911, by States and uses.

1910.

State.	Number of operators.	Roofing slate.			Mill stock.						Other.	Total value.
		Number of squares.	Value.	Average price per square.	Manufactured.		Rough.		Total.			
					Quantity.	Value.	Quantity.	Value.	Quantity.	Value.		
					Square feet.		*Square feet.*		*Square feet.*			
California	1			$7.50								(a)
Georgia	2			6.05								(a)
Maine	6	16,708	$99,023	5.93	385,307	$149,982			385,307	$149,982		$249,005
Maryland	4	14,529	77,791	5.35							$782	78,573
New Jersey	2			4.50								(a)
New York	6	17,618	84,089	4.77			2,933	$733	2,933	733		84,822
Pennsylvania	104	777,190	2,809,593	3.62	3,036,393	508,461	440,133	31,111	3,476,526	539,572	b 391,641	3,740,806
Tennessee	1			4.50								(a)
Vermont	48	395,640	1,585,324	4.01	1,085,894	278,202	230,838	30,609	1,316,732	308,811	524	1,894,659
Virginia	7	31,787	148,721	4.68								148,721
Other States c		7,149	40,123								50	40,173
Total	181	1,260,621	4,844,664	3.84	4,507,594	936,645	673,904	62,453	5,181,498	999,098	392,997	6,236,759
1911.												
Arkansas	2			$7.08								(a)
Georgia	1			5.50								(a)
Maine	5	14,879	$98,074	6.59	394,531	$165,442			394,531	$165,442		$263,516
Maryland	4	14,816	74,692	5.04							$1,343	76,035
New Jersey	2			4.03								(a)
New York	9	21,452	120,359	5.61								120,359
Pennsylvania	97	699,344	2,508,435	3.59	3,694,621	547,725	335,042	$27,241	4,029,663	574,966	d 347,950	3,431,351
Vermont	49	328,760	1,335,244	4.06	1,145,703	261,787	174,680	25,410	1,320,383	287,197	2,500	1,624,941
Virginia	7	40,040	188,808	4.72								188,808
Other States c		5,386	22,959								50	23,009
Total	176	1,124,677	4,348,571	3.87	5,234,855	974,954	509,722	52,651	5,744,577	1,027,605	351,843	5,728,019

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[a] Included in Other States.

[b] Composed of 5,610,518 school slates, valued at $47,075; 2,821,689 square feet of blackboard material, valued at $334,070; and $10,496 for slate used for structural and other purposes.

[c] Includes, in 1910, California, Georgia, New Jersey, and Tennessee; in 1911, Arkansas, Georgia, and New Jersey.

[d] Composed of 4,308,292 school slates, valued at $35,153; 2,636,650 square feet of blackboard material, valued at $300,034; and $34,653 for slate used for structural and other purposes.

The following table shows the total value of the slate produced in the United States from 1907 to 1911, inclusive:

Value of slate produced in the United States, 1907–1911, by States.

State.	1907	1908	1909	1910	1911
Arkansas	$8,500	$2,500			(a)
California	60,000	60,000	(a)	(a)	
Georgia			(a)	(a)	(a)
Maine	236,606	213,707	$227,882	$249,005	$263,516
Maryland	116,060	102,186	129,538	78,573	76,035
New Jersey	8,000	130,619	(a)	(a)	(a)
New York	83,485		107,436	84,822	120,359
Pennsylvania	3,855,640	3,902,958	2,892,358	3,740,806	3,431,351
Tennessee				(a)	
Vermont	1,477,259	1,710,491	1,841,589	1,894,659	1,624,941
Virginia	173,670	194,356	180,775	148,721	188,808
Other States [c]			[b] 61,840	[c] 40,173	[d] 23,009
Total	6,019,220	6,316,817	5,441,418	6,236,759	5,728,019

[a] Included in Other States.
[b] Includes California, Georgia, and New Jersey.
[c] Includes California, Georgia, New Jersey, and Tennessee.
[d] Includes Arkansas, Georgia, and New Jersey.

The following table shows the value of slate produced for roofing and for mill stock from 1907 to 1911, inclusive:

Value of roofing slate and mill stock, 1907–1911.

	Roofing slate.		Value of mill stock.	Total value.
	Number of squares.	Value.		
1907	1,277,554	$4,817,769	$1,201,451	$6,019,220
1908	1,333,171	5,186,167	1,130,650	6,316,817
1909	1,133,713	4,394,597	1,046,821	5,441,418
1910	1,260,621	4,844,664	1,392,095	6,236,759
1911	1,124,677	4,348,571	1,379,448	5,728,019

PRICES.

The following table shows the average price of roofing slate per square since 1904:

Average annual price per square of roofing slate for the entire country.

1904	$3.78	1908	$3.89
1905	3.69	1909	3.87
1906	3.66	1910	3.84
1907	3.77	1911	3.87

IMPORTS.

Practically no slate is imported into the United States. In 1911 slate valued at $8,367 was imported in the form of mantels, chimney pieces, roofing slate, slabs, etc. In 1910 the importations were valued at $4,127, and included the same articles.

EXPORTS.

For a period of about nine years, or from 1897 to 1905, the United States had a large export trade in slate, the years 1898 and 1899 showing exports valued at more than $1,000,000. About two-thirds of these exports were to the United Kingdom, where a strike in the large Welsh quarries enabled slates from other countries to gain a foothold. Since 1905 there has been a marked decrease in slate exports from the United States until in 1909 the exports amounted to only $209,383. Since that year exports of slate have not been kept separate from exports of other varieties of stone.

SLATE INDUSTRY BY STATES AND LOCALITIES.

The slate production of the United States is practically confined to the northeastern part of the country. Although scattered deposits, more or less developed, occur elsewhere, the eastern slate is shipped to supply markets on the western coast as well as in the central and southern parts of the country. The location of the principal deposits, whether producing in commercial quantities or in process of development, are given below by States.

Arizona.—The Arizona Slate Co. and the Phoenix Slate Co., both of Phoenix, report undeveloped deposits of slate in Maricopa County on which simply assessment work for the holding of the property has been done. A description of the slate from the Phoenix Slate Co.'s property was given in Bulletin 275 of the United States Geological Survey.

Arkansas.—Of some dozen prospective slate quarries in Arkansas the only companies reporting an output for 1911 were the American Slate Co., of Kansas City, Mo., whose quarry is located near Mena, in Polk County, Ark., and the North Wales Slate Co., at Big Fork, Polk County. These companies operated but a short time in order to prove the quarries, and they report a good demand for the slate, but lack of railroad facilities for transportation to market and also a lack of capital for complete development. The slate reported for 1911 was roofing slate. Development work on slate properties has also been done in Pulaski, Saline, Garland, and Montgomery counties.

Full descriptions of these deposits may be found in Bulletins 275 and 430 of the United States Geological Survey and in a report by the Arkansas Geological Survey.[1]

California.—The first commercial output of slate from California was reported in 1889, and since that time, with the exceptions of 1893, 1896, and 1911, there has been a yearly output of slate. The Eureka Slate Co.'s quarries at Placerville, Eldorado County, were operated in 1910 until May 1, when they closed in order to enlarge the quarry to meet increased demand; they were not worked in 1911, but expect to resume operations in May, 1912. No slate was produced from the deposits in Maricopa and Merced counties in 1911. Descriptions of these deposits may be found in Bulletin 275 of the United States Geological Survey and in a report by the California Bureau of

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[1] Dale, T. N., and others, Slate deposits and slate industry of the United States: Bull. U. S. Geol. Survey No. 275, 1906, pp. 51-55.
Purdue, A. H., Slates of Arkansas: Bull. U. S. Geol. Survey No. 430, 1910, pp. 317-334; The slates of Arkansas, Geol. Survey, Arkansas, 1909.

Mines.[1] A new deposit of slate was discovered in Merced County in 1912 about 11 miles east of Planada, and the California Slate Co. has done considerable development work and shipped in quarrying machinery. The deposit is said to be 2 miles long and 3 miles wide. A sample of slate received at the United States Geological Survey indicated a roofing slate of very good quality. T. Nelson Dale, of the Survey, makes the following report after an examination of a specimen of slate from this quarry:

> This slate is of dark bluish-gray color, with a somewhat lustrous very finely granular surface with minute striations along the grain. Its fissility is good. It is very sonorous, indicating a high degree of metamorphism, does not effervesce with cold dilute hydrochloric acid nor show any carbonate in thin section, indicating durability of color. It is graphitic and contains many bronze-colored magnetic particles. Magnetite is not certainly present.
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> Under the microscope it shows a matrix of muscovite (sericite) very even in the grain direction with brilliant aggregate polarization, also conspicuous lenses with a nucleus of black mica (biotite). The biotite scales lie mostly parallel to the grain direction and the lenses, partly biotite and partly quartz, are elongated in the grain direction, but the biotite nucleus is crossed by parallel bands of dark inclusions that lie in the cleavage direction. It also contains many bronze-colored metallic particles and minute lenses of a highly magnetic mineral, presumably pyrrhotite (magnetic pyrites). The chief constituents of this slate, arranged in descending order of abundance, appear to be muscovite, quartz, biotite, kaolin, graphite, and pyrrhotite. Magnetite and rutile are not certainly present.
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> This is a mica slate free from carbonate, with good cleavage. It should discolor but little if at all, but its content of magnetic particles makes it unsuitable for electric uses.

Colorado.—At the slate property of the Colorado Slate Co., at Marble, Gunnison County, development work only was done on the quarry. A description of the slate from this quarry, by T. Nelson Dale, of the United States Geological Survey, was given in the report on the production of slate in 1910.

Georgia.—Since 1880 a commercial slate output from Georgia has been reported at irregular intervals, but as development work has been quite continuous it is probable that some of the slate produced in the course of opening the quarries found a local market and was not reported. Transportation rates and want of capital for continuous development appear to have worked against the industry in this State. No slate was quarried at the Rockmart (Polk County) deposits in 1911. There is considerable shale on top of slate suitable for use as roofing and mill stock, and at present this shale is being used to make brick while the slate is being uncovered. The slate at Rockmart has also been used, mixed with limestone quarried in the immediate vicinity, in the making of Portland cement.

The quarry of the Georgia Green Slate Co., of Bartow County, which began operations in 1910, was also worked in 1911, the production and manufacture of the slate being incidental to the development of the quarry. A description of the slate from this quarry was given in the report on the slate industry of the United States for 1910.

There was a slight decrease in the value of output in 1911 from 1910, and the product, all roofing slate, had an average price per square of $6.05 in 1910 and of $5.50 in 1911.

Maine.—The slate quarried in Piscataquis County, has had an extensive use, both for roofing and for mill stock—especially as slate milled for electrical purposes. In 1911, Maine was one of the four slate-producing States to show an increased value of output. Of the five companies reporting an output of slate in 1911 but three were in active operation, the other two sold slate from stock with quarries idle. The operators reported demand better than supply, with price somewhat advanced to keep ahead of increased cost of labor and supplies. There was an increase of development work during 1911, and a new quarry was opened.

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[1] The structural and industrial materials of California: Bull. California State Min. Bur No. 38, 1906, pp. 149–154.

The total value of the slate output in Maine in 1911 was $263,516, a gain of $14,511 over 1910, when the value was $249,005. The increase was in quantity and value of the milling stock, as the roofing slate decreased in both quantity and value, but increased in average price per square. In 1911 a production of 394,531 square feet of mill stock, valued at $165,442 was reported; in 1910, 385,307 square feet, valued at $149,982—an increase for 1911 of 9,224 square feet in quantity and of $15,460 in value. This was all reported as manufactured, and the average price per square foot was 42 cents in 1911 against 39 cents in 1910. The roofing slate decreased from 16,708 squares, valued at 99,023 in 1910, to 14,879 squares, valued at $98,074 in 1911—a decrease of 1,829 squares in quantity and of $949 in value. The average price per square was $6.59 in 1911 and $5.93 in 1910.

Descriptions of the quarries and slate deposits of Maine may be found in Bulletin 275 of the United States Geological Survey.

Maryland.—Although the demand for Maryland slate was reported as exceptionally good during 1911, there was little activity among the quarries except for the purpose of developing and improving quarry conditions. The sales of roofing slate during the year increased in quantity, but decreased in average price per square. All of the slate quarried was in Harford County, and was valued at $76,035 in 1911, compared with $78,573 in 1910, a decrease of $2,538. The average price per square was $5.04 in 1911 as against $5.35 in 1910. Descriptions of the quarries and of the slate may be found in Bulletin 275 of the United States Geological Survey and in a report of the Maryland Geological Survey.[1]

Massachusetts.—Massachusetts was one of the first States in which slate quarries were opened in the United States—at Lancaster, Worcester County, but these have long since been discontinued—as a source of slate for roofing and also for mineral paint. Slate also occurs in Massachusetts in Middlesex County, near Cambridge and Somerville, but it is not sufficiently fissile for use as roofing slate or mill stock; its use is confined entirely to crushed stone, and therefore is not considered in this report.

Minnesota.—A deposit of slate said to be suitable for roofing occurs near Thompson, Carlton County, Minn., but the quarries are abandoned, and no slate has been taken out for several years.

Nevada.—So far as reported to this office, no development work has been done on the deposit of "black" slate in Humboldt County, Nev., described in the report on the slate industry for 1908.

New Jersey.—Slate is quarried in Sussex County, N. J., by the Lafayette Slate Co., at La Fayette, and by the Newton Slate Co., at Newton. Deposits in Warren County near the Delaware Water Gap have not been worked in several years. The New Jersey slate is used entirely for roofing, and the output increased both in quantity and in value in 1911 but decreased in the average price per square, which was $4.03 in 1911 and $4.50 in 1910. A description of this slate was given in the report on the slate industry for 1909, and descriptions of the slate and of the deposits have been published by the New Jersey Geological Survey.[1]

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[1] Maryland Geol. Survey, vol. 2, pp. 214-232.

New York.—The slate output of New York in 1911 was entirely for roofing slate and was all produced in Washington County, in the northeastern part of the State and adjacent to the slate-producing region of Rutland County, Vt. The output in 1911 was 21,452 squares, valued at $120,359, or $5.61 per square; in 1910 the output was 17,618 squares, valued at $84,089, or $4.77 per square, an increase for 1911 of 3,834 squares in quantity, of $36,270 in value, and of 84 cents in average price per square. The price of roofing slate in New York varies perhaps more than any other State on account of its red slate, which commands an extra high price. There was more red slate reported by the quarrymen in 1911 than in 1910, and demands for all kinds of slate was greater than in 1910. A description of the New York Slate deposits is given in Bulletin 275 of the United States Geological Survey.

Pennsylvania.—There was a decrease of $309,455 in the value of the Pennsylvania slate output in 1911, the figures being $3,431,351 for 1911 and $3,740,806 for 1910. This decrease was in the quantity and value of roofing slate and in mill stock for blackboard and school slate, the mill stock used for other purposes increasing in both quantity and value.

The fluctuations were as shown in the following paragraphs.

In 1911 the output of roofing slate was 699,344 squares, valued at $2,508,435; in 1910 it was 777,190 squares, valued at $2,809,593, a decrease of 77,846 squares in quantity and of $301,158 in value. The average price per square decreased from $3.62 in 1910 to $3.59 in 1911.

The value of the slate production in Pennsylvania in 1911 represented 59.90 per cent of the total output of the United States, as compared with 59.98 per cent in 1910, 53.15 per cent in 1909, and 61.79 per cent in 1908. Pennsylvania slate is used both for roofing and for milling stock. In 1911 Pennsylvania produced 62.18 per cent of the total quantity and 57.68 per cent of the total value of the output of roofing slate in the United States. The average price per square in Pennsylvania in 1911 was $3.59, compared with $3.62 in 1910, a decrease of 3 cents. Besides leading in the production of roofing slate, Pennsylvania has a larger output of mill stock than any other State, producing in 1911, exclusive of blackboard stock and school slate, 55.95 per cent of the total value and 70.14 per cent of the total quantity of this material for the United States. Mill stock for other purposes than blackboards and school slates increased from 3,476,526 square feet, valued at $539,572, in 1910 to 4,029,663 square feet, valued at $574,966, in 1911, an increase of 553,137 square feet in quantity and of $35,394 in value. It is noticeable, however, that the increase was in the value of the manufactured mill stock sold and that the rough stock sold directly to slate mills decreased slightly. The average price per square foot was 16 cents in 1910 and 14 cents in 1911.

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[1] Ann. Rept. State Geologist for 1908, Geol. Survey New Jersey, pp. 98–107.

Blackboard slate decreased from 2,821,689 square feet, valued at $334,070, in 1910 to 2,636,650 square feet, valued at $300,034, in 1911, a decrease of 185,039 square feet in quantity and of $34,036 in value. The average price per square foot in 1910 was 11.8 cents; in 1911 it was 11.4 cents.

School slates decreased from 5,610,518 slates, valued at $47,075, in 1910 to 4,308,292 slates, valued at $35,157, in 1911. The average price per thousand was $8.39 in 1910 and $8.16 in 1911.

In 1911 the slate of this State was quarried in Carbon, Lancaster, Lehigh, Northampton, and York counties.

One quarry was operated in Carbon County in 1911. Demand and prices were both reported as better than in 1910 and there was an increased output. A description of the slate from this quarry was given in the report of the production of slate for 1909.

The slate deposit in Dauphin County, a description of which was given in the report of the production of slate for 1910, has never been developed.

In 1910 and 1911 development work was done on slate property near Peters Creek, in Lancaster County, and a small production has been reported from that place. A sample of slate sent by Mr. P. B. Shank, of Peters Creek, to the United States Geological Survey showed a very good quality of slate, resembling closely the York County slate, and a microscopic examination of this slate by T. Nelson Dale, of the United States Geological Survey, gave the following results:

> The color of this slate is very dark gray, slightly bluish. The cleavage surface is fairly smooth, with minute striations in the grain direction, lustrous. The fissility is fair, grade (2). It is very sonorous. There is no effervescence with cold dilute hydrochloric acid nor any carbonate in thin section. It is very graphitic and shows no pyrite on sawn edge; there was a little magnetite in the powdered slate and in thin section.
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> Under the microscope it shows a matrix of muscovite (sericite) very even in grain direction with marked aggregate polarization and containing considerable quartz and finely disseminated graphite. Its most conspicuous feature is the abundance of groups of intergrown rutile crystals (sagenite). These groups measure up to 0.04 millimeter in diameter and average about 15 per square millimeter of thin section. A chemical analysis of the slate would probably show an unusually high percentage of TiO_2 (titanium dioxide) for a slate. There are also andalusite prisms (aluminum silicate) up to 0.066 by 0.009 millimeter, more or less darkened by inclusions and lying mostly with their long axis in the grain direction. A little tourmaline is present, and probably chlorite. The constituents, arranged in descending order of abundance, appear to be muscovite, quartz, graphite, andalusite, rutile, chlorite (?), magnetite, tourmaline, pyrite, and zircon.
>
> This is a graphitic mica slate free from carbonate. It will not discolor and ought to prove very durable. Its cleavage appears to correspond with that of the "Peach Bottom slates," which it generally resembles.

The slate from Lehigh County is used for roofing slate and ordinary mill stock, and also, on account of the fineness of its cleavage, for school slates and blackboard material. In 1910 Lehigh County produced 27.89 per cent of the quantity and 24.84 per cent of the value of the Pennsylvania roofing slate output, and 17.19 per cent of the quantity and 14.41 per cent of the value for the entire United States. In 1911 the Lehigh County production was 22.90 per cent of the quantity and 22.56 per cent of the value of the Pennsylvania roofing slate, and 14.24 per cent of the quantity and 13.02 per cent of the value for the United States. There was a general decrease both in quantity and value of the slate produced in this county in

1911 as compared with 1910 and there were also fewer producers. Although some of the producers reported a good demand for 1911, the larger number reported dull trade, poor demand, and lower prices. The average price per square of roofing slate, however, increased from $3.22 in 1910 to $3.53 in 1911. There was a considerable increase in quantity of mill stock, but a decrease in value of output.

The slate of Northampton County has the same uses as the Lehigh County slate, but the total value of the output is over three times as large. In 1910 Northampton County produced 70.27 per cent of the quantity and 72.48 per cent of the value of the Pennsylvania roofing slate, and 43.32 per cent of the total quantity and 42.03 per cent of the total value for the United States. In 1911 the Northampton County output was 74.62 per cent of the quantity and 73.78 per cent of the value of the Pennsylvania roofing slate, and 46.40 per cent of the quantity and 42.56 per cent of the value for the entire United States. There was a decrease of $114,752 in the output of this county compared with 1910. The value in 1911 was $2,565,888; in 1910 it was $2,680,640. The producers generally reported a fair demand for roofing slate, but with lower prices and few sales of high-grade slates. The average price per square decreased from $3.73 in 1910 to $3.55 in 1911. The demand for mill stock was better than for roofing slate and the manufactured mill stock increased both in quantity and in value, but the demand was not good for blackboard or school slates, although the blackboard output increased both in quantity and in value.

York County produces nothing but roofing slate and of the same Peach Bottom variety as Harford County, Md. There was an increase in production for this county in 1911, but a slight decrease in average price—from $5.60 in 1910 to $5.55 in 1911. There was a general report of greater demand and better trade conditions throughout this region.

Full descriptions of the slate and of the slate deposits of Lehigh, Northampton, and York counties may be found in Bulletin 275 of the United States Geological Survey.

The Pennsylvania slate is mostly of a dark-gray or other dark color. Many of these dark slates, however, become somewhat lighter in color on exposure to the atmosphere.

The following table shows in detail the production of slate in Pennsylvania, by counties and uses, 1910 and 1911:

Production of slate in Pennsylvania in 1910 and 1911, by counties and uses.

1910.

County.	Number of operators.	Roofing slate.			Mill stock.								Other (value).	Total value.
		Number of squares.	Value.	Price per square.	Manufactured.		Rough.		Blackboards.		School slates.			
					Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.		
					Sq. ft.		*Sq. ft.*		*Sq. ft.*		*Number.*			
Carbon	1	14,291	$75,191	$2.25										$75,191
York	4			5.60										
Lehigh	43	216,743	697,964	3.22	294,730	$73,092	173,052	$18,578	1,522,741	$172,448	2,627,821	$22,429	$464	984,975
Northampton	56	546,156	2,036,438	3.73	2,741,663	435,369	267,081	12,533	1,298,948	161,622	2,982,697	24,646	10,032	2,680,640
Total	104	777,190	2,809,593	3.62	3,036,393	508,461	440,133	31,111	2,821,689	334,070	5,610,518	47,075	10,496	3,740,806
1911.														
Carbon	1	17,354	$91,573	$3.58										$91,573
Lancaster	1			5.00										
York	5			5.55										
Lehigh	34	160,150	566,101	3.53	506,461	$60,710	194,941	$19,078	1,040,593	$107,967	1,832,293	$14,971	$5,063	773,890
Northampton	57	521,840	1,850,761	3.55	3,188,160	487,015	140,101	8,163	1,596,057	192,067	2,475,999	20,186	7,696	2,565,888
Total	98	699,344	2,508,435	3.59	3,694,621	547,725	335,042	27,241	2,636,650	300,034	4,308,292	35,157	12,759	3,431,351

Tennessee.—No slate was reported in 1911 from the slate deposits of Tennessee.

Utah.—No slate was quarried in 1911 at the slate deposits at Provo, Utah County, owned by the Utah Slate & Granite Co., but some development work was done in these deposits in 1911.

Vermont.—Vermont ranks next to Pennsylvania in the production of slate, and in 1911 produced 28.37 per cent of the total value of the United States output, as compared with 59.90 per cent produced by Pennsylvania. In 1910 these figures for Vermont and Pennsylvania were 30.38 and 59.98 per cent, respectively—a decrease for both States, but one practically negligible for Pennsylvania. The value of the Vermont slate decreased from $1,894,659 in 1910 to $1,624,941 in 1911—a decrease of $269,718. This loss was chiefly in the roofing slate, which declined from 395,640 squares, valued at $1,585,324, in 1910, to 328,760 squares, valued at $1,335,244, in 1911—a decrease of 66,880 squares in quantity and of $250,080 in value. The average price per square increased from $4.01 in 1910 to $4.06 in 1911.

The output of mill stock increased in quantity from 1,316,732 square feet in 1910 to 1,320,383 square feet in 1911, an increase of 3,651 square feet, with a loss of $21,614 in value, from $308,811 in 1910 to $287,197, in 1911. The average price of the mill stock in 1911 was 21.8 cents, as compared with 23.5 cents in 1910. Of the mill stock (exclusive of blackboards and school slates) produced in the United States, Vermont produced 27.95 per cent of the total value in 1911, compared with 55.95 per cent from Pennsylvania. Most of the producers reported the demand and general conditions of the trade about the same as in 1910, a fair demand for colored slates, and only average demand for mill stock.

The Vermont slate is practically all from Rutland County, and the quarries are in the same belt as the New York slate quarries. The Rutland County slate varies in color and is known in the trade as "sea green," "grayish green," "unfading green," "greenish gray," "purple," "purplish brown," "variegated," and other variations of green, gray, and purple.

The Vermont quarries and slate are fully described in Bulletin 275 of the United States Geological Survey.

Virginia.—The slate quarried in Virginia is used entirely for roofing, the production in 1911 being 40,040 squares, valued at $188,808, or $4.72 per square. This was an increase of 8,263 squares in quantity and of $40,087 in value as compared with 1910. The slate industry of Virginia in 1910 was crippled by a strike. More slate was sold in 1911 than in 1910, but the general demand was reported as very slow, with little incentive for further development of quarries. Prices remained about the same. The average price per square in 1911 was $4.72; in 1910 it was $4.68.

The Virginia slate in 1911 was produced at Esmont, Albemarle County, and Arvonia and Penlan, Buckingham County. A description of these quarries may be found in Bulletin 275 of the United States Geological Survey.

PUBLICATIONS ON SLATE.

Requests are continually coming to the United States Geological Survey for reports on the distribution, production, composition, and methods of working quarries of slate.

Bulletin 275 of the United States Geological Survey,[1] which is a very comprehensive report on the slate and slate deposits of the United States, is now out of print, but can be consulted in libraries or purchased from dealers in second-hand books. This report, however, is at present being revised.

A map showing the commercial deposits of slate will be published in the report on the stone industry of the United States for 1911. The United States Geological Survey has published a report on the slates of Arkansas, by A. H. Purdue.[2]

The State geological surveys of Arkansas, California, Maryland, and New Jersey have also published descriptions of the slate and slate deposits of those States, and information may be had of these publications by applying to the State geologists of the respective States.

A recent publication by E. C. Eckel[3] contains a chapter on slate, which gives general information on the slates of the United States and foreign countries and also many analyses and tests of slate.

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[1] Dale, T. N., and others, Slate deposits and slate industry of the United States: Bull. U. S. Geol. Survey No. 275, 1906.

[2] Purdue, A. H., The slates of Arkansas: Bull. U. S. Geol. Survey No. 430, 1910, pp. 317-334.

[3] Eckel, E. C., Building stones and clays, their origin, character, and examination, John Wiley & Sons, New York, 1912.

ERRATUM.

After this volume (Part II) had been sent to press an error of $141,869 was discovered in the figures for the value of granite produced in South Carolina, which should be $335,617. The correction will be made in the Introductory chapter and in the Summary, Part I.

STONE.

By Ernest F. Burchard.

INTRODUCTION.

The present report on the stone industry differs from those of previous years in that it includes, besides the usual large amount of statistical data on the production of the various commercial types of stone subdivided into the several forms in which the stone is marketed, the beginning of a general discussion of the stone resources of the United States. This discussion is illustrated by seven maps, which show the location of stone quarries by types of stone in all States east of Mississippi River. It is hoped to continue, if not to finish, this discussion in the chapter for the year 1912.

This report chronicles no important industrial changes in 1911 compared with 1910. The stone industry showed none of the marked reductions in output that characterized certain other of the leading industries in 1911, and this fact is an encouraging indication of the stability of the industry, for it is well known that stone has suffered severe competition from other types of structural materials within the last few years. If there have been decreases in the output of the more expensive grades of stone, they apparently have been nearly offset by the increase in the output of crushed stone, which at one time was considered only a by-product.

In the statistical part of this report, which is entirely the work of Miss A. T. Coons, of the United States Geological Survey, several new tables are presented for the first time, giving not only values but quantities of output, and it is expected that so far as the data at hand permit the stone statistics will from year to year be improved by the inclusion of quantitative data.

A very large part of the work in the preparation of the quarry maps and quarry directories was done by Miss Olive Zeph, of the Survey.

The figures presented in the following report, as in previous years, have to do with the stone produced and sold by the quarrymen and include only such manufactured product as is put on the market by the quarrymen themselves. This applies especially to rough and dressed building stone, dressed monumental stone, crushed stone, flagstone, curbstone, and paving blocks. The value given to this manufactured product is the price received by the producer free on board at point of shipment, and includes therefore the cost of labor necessary to dress the stone. The stone reported as sold rough includes stone sold as rough stock to monumental works and to cut-stone contractors for building purposes; stone sold as riprap, rubble, and flux; and includes the value of only such labor as is required to get the stone out of the quarry in the shape required by the purchaser. The value given to this stone is the price received by the quarryman free on board at point of shipment. In case the stone is sold to local trade the value is given as the quarryman sells the material, generally at the quarry, but in some cases delivered, if this is done by the producer. In some instances a long haul to market or to the railroad increases the cost of the material, and therefore of the selling price.

For simplicity of treatment the kinds of stone covered by the figures in this report are classified as granite, trap rock, sandstone, bluestone, limestone, and marble.

Granite includes true granites and other igneous rocks, as gneiss, mica schist, andesite, syenite, trachyte, quartz porphyry, lava, tufa, diabase, basalt, diorite, gabbro, dolerite, and a small quantity of serpentine. Rocks of these kinds are as a rule quarried commercially in quantities too small to permit their being tabulated separately, but the trap-rock output for California, Massachusetts, New York, New Jersey, and Pennsylvania represents an important industry, and it is therefore considered advisable to show the value of this stone separately. The trap rock from these States consists largely of basalt.

Sandstone includes the quartzites of South Dakota and Minnesota and the fine-grained sandstones of New York and Pennsylvania, known to trade as bluestone. As the bluestone is a product of a distinct industry, its production is also shown apart from that of the other sandstones. Bluestone is also quarried in New Jersey and West Virginia, but this product is small and is not separated from sandstone. In Kentucky most of the sandstone quarried and sold is known locally as freestone. The figures given for sandstone do not include the value of the grindstones, whetstones, and pulp stones made from sandstones quarried in Michigan, Ohio, and West Virginia; nor does the total sandstone value include sandstone crushed into sand and used in the manufacture of glass and as molding sand. The production of these materials is published in other chapters of this volume.

Limestone does not include limestone burned into lime, bituminous limestone, nor limestone entering into the manufacture of Portland cement. It includes, however, a small quantity of stone sold locally as marble.

Marble includes a small quantity of serpentine quarried and sold as marble in Georgia and Pennsylvania, and also a small quantity of the so-called "onyx" marble or travertine obtained from caves and other deposits.

UNIT OF MEASUREMENT.

Owing to the variety of uses to which stone is put there is no regular unit of measurement employed by the quarrymen, the stone being sold by the cubic yard, the cubic foot, the ton, cord, perch, rod square foot, square yard, square, etc. Building and monumenta stone, especially the dressed product, is usually sold by the cubic foot or the cubic yard, although this unit varies with the class o stone and with the locality; a large quantity of the rough stone i sold by the perch, cord, and ton. Rubble and riprap, including stone for heavy masonry, such as breakwater and jetty work, are generally sold by the cord and ton. Fluxing stone and stone for chemical use—as for alkali works, sugar factories, carbonic-acid plants, paper mills, etc.—are sold by the long ton. Flagstone and curbstone are sold by the square yard and the square foot, the thickness being variable and depending on the order received by the quarrymen. Paving blocks are sold invariably by number of blocks, and as such have been tabulated and published for several years; these blocks, however, are not of uniform size, the value depending on the size and amount of labor necessary to cut the block into the shape desired. Crushed stone is reported as sold by the cubic yard or ton, the short ton being more generally used. The weight of a cubic yard varies from 2,300 to 3,000 pounds, the average weight being 2,500 pounds. In certain localities this crushed stone is sold by the "square" of 100 square feet by 1 foot, or 100 cubic feet to a square. It is also of interest to note the selling of crushed stone by the bushel, 21½ bushels representing a cubic yard of about 2,700 pounds. As most of the crushed-stone producers report the quantity according to some unit, it has been possible to convert the crushed stone into short tons, which unit represents the larger number of producers and is the most convenient.

The statistical inquiry cards showing the production of building stone, monumental stone, rubble, and riprap, do not always report the quantity, but it has been possible to publish in this report the quantity as well as the value of the granite production of Maine and Vermont; of the limestone production in the Bedford, Ind., Carthage, Mo., and Bowling Green, Ky., limestone districts; and of the marble produced in California, Georgia, Massachusetts, New York, Pennsylvania, Tennessee, and Vermont.

PRODUCTION.

The total value of the stone produced in the United States in 1911 was $76,966,698, as compared with $76,520,584 in 1910, an increase of $446,114, or about 0.6 per cent. The year 1911 surpassed all previous years in the value of its stone output. The values of granite, marble, and bluestone each showed an increase in 1911 over those of 1910; but the value of sandstone, trap rock, and limestone decreased slightly.

The increase, however slight, in the value of the stone produced in 1911 is of interest when it is considered that the production of many other minerals, for instance, iron ore, decreased considerably.

In 1911 the total value of the stone output for Pennsylvania exceeded that for any other State. Pennsylvania has held first rank in recent years, except in 1908 when Vermont reported the largest production. Other large stone-producing States are California, Illinois, Indiana, Maine, Massachusetts, Missouri, New York, Ohio, Vermont, and West Virginia, each of whose production was valued at more than $2,000,000, and there were 12 States in 1911 that produced stone valued at between $1,000,000 and $2,000,000.

The following table shows the value of the different kinds of stone produced in the United States from 1901 to 1911, inclusive:

Value of the different kinds of stone produced in the United States, 1901–1911.

Year.	Granite.	Trap rock.	Sandstone.	Bluestone.	Marble.	Limestone.	Total.
1901	$14,266,104	$1,710,857	$6,974,199	$1,164,481	$4,965,699	$18,202,843	$47,284,183
1902	16,083,475	2,181,157	9,430,958	1,163,525	5,044,182	20,895,385	54,798,682
1903	15,703,793	2,732,294	9,482,802	1,779,457	5,362,686	22,372,109	57,433,141
1904	17,191,479	2,823,546	8,482,162	1,791,729	6,297,835	22,178,964	58,765,715
1905	17,563,139	3,074,554	8,075,149	1,931,625	7,129,071	26,025,210	63,798,748
1906	18,562,806	3,736,571	7,147,439	2,021,898	7,582,938	27,327,142	66,378,794
1907	18,064,708	4,594,103	6,753,762	2,117,916	7,837,685	31,737,631	71,105,805
1908	18,420,080	4,282,406	5,831,231	1,762,860	7,733,920	27,682,002	65,712,499
1909	19,581,597	5,133,842	6,564,052	1,446,402	6,548,905	32,070,401	71,345,199
1910	20,541,967	6,452,141	6,394,832	1,535,187	6,992,779	34,603,678	76,520,584
1911	21,391,878	6,399,622	5,854,395	1,876,473	7,546,718	33,897,612	76,966,698

The foregoing table shows the following relations between the values of the various classes of rock and the changes that occurred in the totals from 1910 to 1911:

Granite.—The value of granite represented nearly 28 per cent of the total value of stone in 1911. The increase in value was from $20,541,967 in 1910 to $21,391,878 in 1911, or $849,911. Granite for building and crushed stone increased in value, but there was a decrease in the value of granite for monumental work, curbing, flagging, and paving.

Trap rock.—Trap rock decreased in value from $6,452,141 in 1910 to $6,399,622 in 1911, or $52,519. The trap-rock output is chiefly crushed stone.

Sandstone.—Sandstone, including quartzite, decreased in value from $6,394,832 in 1910 to $5,854,395 in 1911, or $540,437.

Bluestone.—The value of bluestone increased from $1,535,187 in 1910 to $1,876,473 in 1911, an increase of $341,286.

Marble.—The value of marble represented more than 7 per cent of the total stone value in 1911, and increased from $6,992,779 in 1910 to $7,546,718 in 1911, or $553,939.

Limestone.—The value of limestone represented more than 44 per cent of the total value of stone produced in 1911. It decreased from $34,603,678 in 1910 to $33,897,612 in 1911, or $706,066.

The following table shows the value of the various kinds of stone produced in 1910 and 1911, by States and Territories:

Value of various kinds of stone produced in 1910 and 1911, by States and Territories.

1910.

State or Territory.	Granite.	Trap rock.	Sandstone.	Marble.	Limestone.	Total value.
Alabama			$109,063	[a] $255,664	$714,516	$1,079,243
Alaska				(a)		(a)
Arizona	(b)		131,716	(a)	(c)	131,716
Arkansas	$226,690		71,641		84,280	382,611
California	1,520,299	$1,955,335	113,488	[a] 112,339	590,990	4,292,451
Colorado	93,679		189,603	[a] 488,173	415,523	1,186,978
Connecticut	410,535	500,229	(d)		[c] 9,062	919,826
Delaware	357,708					357,708
Florida					[c] 84,457	84,457
Georgia	1,049,186			953,917	24,236	2,027,339
Hawaii	139,724					139,724
Idaho	(b)		34,070		19,423	53,493
Illinois			5,710		3,847,715	3,853,425
Indiana			4,141		4,472,241	4,476,382
Iowa			14,456		543,600	558,056
Kansas			25,691		768,739	794,430
Kentucky			90,729	(a)	978,809	1,069,538
Louisiana					(c)	(c)
Maine	2,315,730				(c)	2,315,730
Maryland	982,746		18,226	(a)	154,370	1,155,342
Massachusetts	1,567,754	797,048	[d] 424,485	[a] 224,088	(c)	3,013,375
Michigan	(b)		31,233		842,126	873,359
Minnesota	858,734		483,578		654,833	1,997,145
Missouri	120,663		39,398		2,360,604	2,520,665
Montana	(b)		59,019		169,836	228,855
Nebraska					338,731	338,731
Nevada			(d)			(d)
New Hampshire	1,239,656					1,239,656
New Jersey	80,105	1,257,712	112,650		224,707	1,675,174
New Mexico	(b)		1,402	(a)	[c] 227,657	229,059
New York	330,716	970,994	[d] 1,810,770	484,732	2,813,476	6,410,688
North Carolina	839,742		(d)	(a)	(c)	839,742
Ohio			1,402,131		4,357,432	5,759,563
Oklahoma	102,566		19,801		509,344	631,711
Oregon	1,080,009		[d] 30,375		3,594	1,113,978
Pennsylvania	478,919	970,823	[d] 1,595,070	[a] 182,514	5,394,611	8,621,937
Rhode Island	521,490				(c)	521,490
South Carolina	369,448				(c)	369,448
South Dakota			156,576		17,150	173,726
Tennessee			(d)	728,502	[c] 747,162	1,475,664
Texas	66,909		40,471		447,239	554,619
Utah	6,783		43,589	(a)	389,603	439,975
Vermont	2,694,474			3,562,850	25,250	6,282,574
Virginia	503,106		25,080		471,903	1,000,089
Washington	642,992		438,581	(a)	36,186	1,117,759
West Virginia			[d] 212,308	(a)	841,064	1,053,372
Wisconsin	1,475,342		189,654		979,522	2,644,518
Wyoming			5,314		43,687	49,001
Other States	[b] 466,262					[b] 466,262
Total	[e] 20,541,967	6,452,141	[f] 7,930,019	6,992,779	34,603,678	76,520,584

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[a] To prevent disclosure of individual production, Alabama includes Kentucky, North Carolina, and West Virginia; California includes Alaska and Washington; Colorado includes Arizona, New Mexico, and Utah; and Pennsylvania includes Maryland.

[b] "Other States" includes Arizona, Idaho, Montana, Nevada, and New Mexico; Minnesota includes a small value of trap rock for Michigan and Minnesota.

[c] Florida includes Louisiana; Connecticut includes Maine, Massachusetts, and Rhode Island; New Mexico includes Arizona; Tennessee includes North Carolina and South Carolina.

[d] Massachusetts includes Connecticut; Oregon includes Nevada; West Virginia includes North Carolina and Tennessee; New York and Pennsylvania include bluestone.

[e] Includes small values for trap, basalt, and other igneous rocks.

[f] Includes bluestone in New York and Pennsylvania, and quartzite in California, Minnesota, South Dakota, and Wisconsin.

Value of various kinds of stone produced in 1910 and 1911, by States and Territories—Continued.

1911.

State or Territory.	Granite.	Trap rock.	Sandstone.	Marble.	Limestone.	Total value.
Alabama	(a)		$73,195	[b] $335,005	$561,798	[a] $969,998
Alaska						(b)
Arizona	$13,105		[c] 57,100	(b)	8,676	78,881
Arkansas	354,041		85,529		(d)	439,570
California	1,738,094	$2,055,930	176,213	129,964	576,701	4,676,902
Colorado	137,356		135,673	[b] 1,010,840	341,798	1,625,667
Connecticut	574,673	472,461	(c)		[d] 21,040	1,068,174
Delaware	218,234					218,234
District of Columbia	(a)					(a)
Florida			(c)		97,520	97,520
Georgia	847,023			1,088,422	31,632	1,967,077
Hawaii	339,519					339,519
Idaho	(a)		40,097		[d] 19,497	59,594
Illinois			30,953		3,436,977	3,467,930
Indiana			7,078		4,406,577	4,413,655
Iowa			56,312		679,895	736,207
Kansas			13,774		789,448	803,222
Kentucky			97,439	(b)	1,124,170	1,221,609
Louisiana					[d] 136,007	136,007
Maine	2,257,034				(d)	2,257,034
Maryland	845,936		10,097	[b] 73,300	218,636	1,147,969
Massachusetts	2,361,624	859,070	[c] 406,072	219,445	(d)	3,846,211
Michigan		51,000	12,985		1,001,535	1,065,520
Minnesota	797,244		292,366		612,915	1,702,525
Missouri	139,070		19,748		2,179,767	2,338,585
Montana	29,670		34,437		148,126	212,233
Nebraska			(c)		263,459	263,459
Nevada	(a)				(d)	(a) (d)
New Hampshire	1,017,272					1,017,272
New Jersey	167,112	1,136,385	155,765		138,148	1,597,410
New Mexico	(a)		4,085	(b)	243,119	[a] 247,204
New York	344,038	959,966	[c] 2,353,995	379,670	2,857,797	6,895,466
North Carolina	772,685		[c] 10,385	(b)	30,278	813,348
Ohio			1,334,947		4,461,882	5,796,829
Oklahoma	20,244		90,971	(b)	594,664	705,879
Oregon	580,978		[c] 1,668	(b)	(d)	582,646
Pennsylvania	491,428	864,810	[c] 1,333,309	214,913	5,243,045	8,147,505
Rhode Island	957,743				(d)	957,743
South Carolina	193,748			(b)	(d)	193,748
South Dakota	(a)		141,615		6,250	147,865
Tennessee			(c)	700,229	[d] 798,369	1,498,598
Texas	70,488		28,000		490,289	588,777
Utah	5,209		41,953	(b)	168,145	215,307
Vermont	2,730,719			3,394,930	19,702	6,145,351
Virginia	420,611		31,315		369,872	821,798
Washington	1,345,551		301,843		32,478	1,679,872
West Virginia			203,935		902,077	1,106,012
Wisconsin	1,382,309		144,430		848,363	2,375,102
Wyoming			3,584		36,960	40,544
Other States	[a] 239,120					[a] 239,120
Total	[e] 21,391,878	6,399,622	[f] 7,730,868	7,546,718	33,897,612	76,966,698

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[a] To prevent disclosure of individual production, Alabama, District of Columbia, Idaho, Nevada, and South Dakota are included for the granite output under "Other States."

[b] Alabama includes Kentucky and Oklahoma; Colorado includes Alaska, Arizona, New Mexico, Oregon, and Utah; and Maryland includes North Carolina and South Carolina.

[c] Arizona includes Florida; Massachusetts includes Connecticut; North Carolina includes Tennessee; Oregon includes Nebraska; New York and Pennsylvania include bluestone.

[d] Connecticut includes Maine, Massachusetts, and Rhode Island; Idaho includes Nevada and Oregon; Louisiana includes Arkansas; Tennessee includes South Carolina.

[e] Includes small values for trap, basalt, and other igneous rocks.

[f] Includes bluestone in New York and Pennsylvania and quartzite in California, Minnesota, South Dakota, and Wisconsin.

The following table shows the rank of States and Territories in 1910 and 1911, according to value of production of stone, and the percentage of the total produced by each State or Territory.

The States showing noteworthy increases were Washington, Colorado, Rhode Island, and Hawaii, and those that showed noteworthy decreases were New Hampshire, Virginia, Oregon, Utah, and Montana.

Rank of States and Territories in 1910 and 1911, according to value of production of stone, and percentage of total produced by each State or Territory.

1910				1911			
Rank of State.	State or Territory.	Total value.	Percentage of total.	Rank of State.	State or Territory.	Total value.	Percentage of total.
1	Pennsylvania	[a]$8,621,937	11.27	1	Pennsylvania	$8,147,505	10.59
2	New York	6,410,688	8.38	2	New York	6,895,466	8.96
3	Vermont	6,282,574	8.21	3	Vermont	6,145,351	7.98
4	Ohio	5,759,563	7.53	4	Ohio	5,796,829	7.53
5	Indiana	4,476,382	5.85	5	California	4,676,902	6.08
6	California	[a] 4,292,451	5.60	6	Indiana	4,413,655	5.73
7	Illinois	3,853,425	5.04	7	Massachusetts	[b] 3,846,211	5.00
8	Massachusetts	[a] 3,013,375	3.94	8	Illinois	3,467,930	4.51
9	Wisconsin	2,644,518	3.46	9	Wisconsin	2,375,102	3.09
10	Missouri	2,520,665	3.29	10	Missouri	2,338.585	3.04
11	Maine	[a] 2,315,730	3.03	11	Maine	[b] 2,257,034	2.93
12	Georgia	2,027,339	2.65	12	Georgia	1,967,077	2.56
13	Minnesota	[a] 1,997,145	2.61	13	Minnesota	1,702,525	2.21
14	New Jersey	1,675,174	2.19	14	Washington	1,679,872	2.18
15	Tennessee	[a] 1,455.889	1.90	15	Colorado	[b] 1,610,434	2.10
16	New Hampshire	1,239.656	1.62	16	New Jersey	1,597,410	2.08
17	Colorado	[a] 1,186,328	1.55	17	Tennessee	[b] 1,499,648	1.95
18	Maryland	[a] 1,155,342	1.51	18	Kentucky	[b] 1,221,609	1.59
19	Washington	[a] 1,117,759	1.46	19	Maryland	[b] 1,152,714	1.50
20	Oregon	[a] 1,114,378	1.46	20	West Virginia	1,106,012	1.44
21	Kentucky	[a] 1,069,538	1.40	21	Connecticut	[b] 1,068,174	1.39
22	Alabama	[a] 1,058,368	1.38	22	Michigan	1,065,520	1.38
23	West Virginia	1,054,192	1.38	23	New Hampshire	1,017,272	1.32
24	Virginia	1,000,089	1.31	24	Rhode Island	[b] 957,743	1.24
25	Connecticut	[a] 919,826	1.20	25	Alabama	923,998	1.20
26	North Carolina	879,572	1.15	26	North Carolina	826,928	1.07
27	Michigan	[a] 873,359	1.14	27	Virginia	821.798	1.07
28	Kansas	794,430	1.04	28	Kansas	803,222	1.04
29	Oklahoma	631,711	.83	29	Oklahoma	[b] 801.879	1.04
30	Iowa	558,056	.73	30	Iowa	736,207	.96
31	Texas	554,619	.72	31	Texas	588,777	.76
32	Rhode Island	[a] 521,490	.68	32	Oregon	[b] 580,978	.75
33	Montana	[a] 456,539	.60	33	Arkansas	[b] 528.947	.69
34	New Mexico	443,650	.58	34	New Mexico	406,454	.53
35	Utah	439,975	.57	35	Hawaii	339,519	.44
36	Arkansas	382,611	.50	36	Nebraska	[b] 268.971	.35
37	South Carolina	[a] 369,448	.48	37	Delaware	218,234	.28
38	Delaware	357,708	.47	38	Utah	[b] 215,307	.28
39	Nebraska	338,731	.44	39	Montana	212,233	.28
40	South Dakota	173.726	.23	40	South Carolina	[b] 193,748	.25
41	Arizona	[a] 155,953	.20	41	Florida	[b] 184,545	.24
42	Hawaii	139,724	.18	42	South Dakota	[b] 147,865	.19
43	Florida	[a] 84,457	.11	43	Idaho	64,250	....
44	Idaho	[a] 53.493	.13	44	Arizona	55,714	.20
45	Wyoming	49,001		45	Wyoming	40,544	
46	Alaska	(a)	....	46	Alaska	(b)	....
47	Louisiana	(a)	....	47	Louisiana	(b)	....
48	Nevada	(a)	....	48	District of Columbia	(b)	....
				49	Nevada	(b)	....
	Total	76,520,584	100.00		Total	76,966,698	100.00

[a] To prevent disclosure of individual figures, Alabama includes a small value for Kentucky; California for Alaska and Washington; Colorado for Arizona and Utah; Connecticut for Massachusetts, Maine, and Rhode Island; Florida for Louisiana; Massachusetts for Connecticut; Minnesota for Michigan; Montana for Idaho; Oregon for Nevada; Pennsylvania for Maryland; and Tennessee for South Carolina.

[b] To prevent disclosure of individual figures, Arkansas includes a small value for Oregon and South Dakota; Colorado for Alaska, Oregon, and Utah; Connecticut for Maine, Massachusetts, and Rhode Island; Florida for Louisiana; Maryland for District of Columbia; Massachusetts for Connecticut; Nebraska for Nevada; Oklahoma for Kentucky; and Tennessee for South Carolina.

The following table shows the value of the stone used for various purposes in 1910 and 1911. Only such values are given as are for uses common to two or more varieties of stone.

Value of granite, trap rock, sandstone, limestone, and marble used for various purposes in 1910 and 1911.

1910.

Kinds.	Building (rough and dressed).	Monumental (rough and dressed).	Flagstone.	Curbstone.	Paving stone.	Crushed stone.
Granite	$5,609,313	$4,716,561	$44,338	$1,019,529	$2,823,772	$4,208,112
Trap rock	87,832				225,645	5,984,908
Sandstone	2,778,892		649,079	881,902	899,595	1,406,153
Limestone	5,272,024		36,807	165,781	464,837	15,665,362
Marble	2,357,795	2,170,981				
Total	16,105,856	6,887,542	730,224	2,067,212	4,413,849	27,264,535

1911.

Kinds.	Building (rough and dressed).	Monumental (rough and dressed).	Flagstone.	Curbstone.	Paving stone.	Crushed stone.
Granite	$6,395,370	$4,265,773	$24,640	$975,104	$2,787,713	$4,346,547
Trap rock	81,830				197,477	5,877,447
Sandstone	2,317,074		749,604	1,124,760	689,826	1,634,074
Limestone	4,721,800		27,409	153,893	482,268	16,548,357
Marble	2,910,267	2,621,213				
Total	16,426,341	6,886,986	801,653	2,253,757	4,157,284	28,406,425

This table shows from a point of view slightly different from that of the preceding tables the changes in the stone industry from 1910 to 1911. The value of stone sold for building purposes showed an increase of $320,485, which was mainly confined to the output of granite and marble. Monumental stone decreased slightly in value in 1911, granite and marble together showing a decrease of $556. Flagstone showed an increase in value of $71,429, the increase being confined to sandstone flagging. The total value of curbstone showed a gain of $186,545 in 1911 as compared with the value for 1910. Only the value of sandstone used for curbing showed an increase. The value of stone used for paving decreased $256,565. The value of granite, sandstone, and trap rock for paving each showed a decrease, but the value of limestone increased slightly. Crushed stone increased $1,141,890 in 1911 above the value in 1910. This increase was shared by the granite, sandstone, and limestone which were sold as crushed stone, but the crushed trap rock showed a slight decrease.

The following table gives in a form convenient for comparison the value of building stone and of crushed stone from 1901 to 1911. The increase in the value of the crushed stone output has been more steady than that of the building stone.

Value of building stone and of crushed stone, 1901–1911.

Year.	Building stone (rough and dressed.)	Crushed stone.	Year.	Building stone (rough and dressed).	Crushed stone.
1901	$15,112,600	$8,560,432	1907	$16,675,811	$22,054,297
1902	20,790,341	11,480,959	1908	16,040,630	20,262,012
1903	19,795,491	13,188,938	1909	17,594,455	24,078,780
1904	18,883,455	15,530,122	1910	16,105,856	27,264,535
1905	20,240,809	16,419,614	1911	16,426,341	28,406,425
1906	20,681,625	17,467,486			

The following table shows the quantity and value of crushed stone produced in the United States in 1910 and 1911, by States and Territories and by uses:

Production of crushed stone in 1910 and 1911, by States and Territories and by uses, in short tons.

1910.

State or Territory.	Road making.		Railroad ballast.		Concrete.		Total.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Alabama	87,802	$64,872	12,465	$5,842	67,887	$72,199	168,154	$142,913
Arizona	9,754	7,225	5,250	5,000	27,363	25,954	42,367	38,179
Arkansas	242,843	185,819	66,178	42,582	38,200	31,160	347,221	259,561
California	1,957,020	1,424,585	595,025	328,855	1,433,544	952,660	3,985,589	2,706,100
Colorado	16,600	26,600	19,728	9,140	29,767	26,474	66,095	62,214
Connecticut	430,023	244,067	242,381	109,616	317,565	167,428	989,969	521,111
Delaware	29,826	23,561	37,794	26,456	60,730	51,637	128,350	101,654
Florida	24,661	30,250	....	....	2,500	3,000	27,161	33,250
Georgia	12,592	10,881	97,455	82,559	310,846	246,824	420,893	340,264
Hawaii	24,949	33,502	500	825	66,808	75,764	92,257	110,091
Idaho	2,700	1,000	....	....	1,875	1,500	4,575	2,500
Illinois	2,075,476	954,409	1,300,282	520,132	2,054,915	953,502	5,430,673	2,428,043
Indiana	1,102,834	551,021	297,889	125,498	259,565	133,186	1,660,288	809,705
Iowa	71,664	57,168	67,852	35,434	335,550	259,262	475,066	351,864
Kansas	98,789	72,965	550,867	271,023	219,371	167,096	869,027	511,084
Kentucky	448,344	288,611	724,132	317,221	269,847	115,602	1,442,323	721,434
Louisiana	....	....	1,750	1,400	20,625	16,500	22,375	17,900
Maine	8,232	8,831	13,242	11,047	3,262	3,792	24,736	23,670
Maryland	523,381	427,430	157,426	77,352	201,972	179,067	882,779	683,849
Massachusetts	594,836	457,367	171,355	81,862	611,180	476,677	1,377,371	1,015,906
Michigan	198,966	110,184	141,093	42,358	443,816	178,318	783,875	330,860
Minnesota	132,805	118,944	26,847	24,091	352,508	295,746	512,160	438,781
Missouri	658,196	530,669	349,403	204,988	587,646	499,447	1,595,245	1,235,104
Montana	450	150	....	....	....	....	450	150
Nebraska	10,000	10,000	....	....	281,006	229,164	291,006	239,164
Nevada	1,250	500	....	....	....	....	1,250	500
New Hampshire	1,203	861	703	611	25,623	17,729	27,529	19,201
New Jersey	907,920	755,918	466,288	269,760	390,125	275,737	1,764,333	1,301,415
New Mexico	....	....	930,797	432,106	19,640	9,367	950,437	441,473
New York	3,069,158	1,804,838	1,119,950	559,080	1,416,069	966,389	5,605,177	3,330,307
North Carolina	159,888	138,216	174,214	98,516	60,824	51,547	394,926	288,279
Ohio	2,894,875	1,314,192	1,955,248	789,130	797,315	377,523	5,647,438	2,480,845
Oklahoma	30,916	20,983	300,066	162,932	34,041	157,892	665,023	341,807
Oregon	320,863	304,646	....	....	81,062	67,715	401,925	372,361
Pennsylvania	1,417,111	816,783	1,873,673	1,024,600	1,328,448	791,318	4,619,232	2,632,701
Rhode Island	28,723	32,136	3,468	3,919	17,974	21,742	50,165	57,797
South Carolina	53,795	49,977	24,741	23,009	79,134	78,375	157,670	151,361
South Dakota	6,390	9,441	....	....	17,905	14,138	24,295	23,579
Tennessee	348,142	279,580	298,485	123,530	176,076	102,788	822,703	505,898
Texas	125,944	92,514	36,437	24,244	226,670	190,104	389,051	306,862
Utah	....	....	....	....	3,200	5,100	3,200	5,100
Virginia	73,863	62,247	507,941	237,940	249,413	192,493	831,217	492,680
Vermont	17,247	13,218	567	234	7,902	8,069	25,716	21,521
Washington	185,212	193,993	560	350	16,095	12,864	201,867	207,207
West Virginia	5,844	3,549	571,251	274,569	74,930	51,677	652,025	329,795
Wisconsin	674,083	377,543	112,259	48,380	623,022	380,208	1,409,364	806,131
Wyoming	....	....	....	....	24,124	22,364	24,124	22,364
Total	19,085,170	11,911,246	13,255,562	6,396,191	13,967,940	8,957,098	46,308,672	27,264,535

Production of crushed stone in 1910 and 1911, by States and Territories and by uses, in short tons—Continued.

1911.

State or Territory.	Road making.		Railroad ballast.		Concrete.		Total.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Alabama	64,703	$37,511	....	....	155,748	$103,077	220,451	$140,588
Arizona	....	....	7,500	$6,000	10,000	10,000	17,500	16,000
Arkansas	24,887	16,627	193,334	153,090	116,763	101,482	334,984	271,199
California	1,878,120	1,259,123	762,858	460,419	1,674,211	1,151,595	4,315,189	2,871,137
Colorado	16,381	21,014	....	....	20,259	13,466	36,640	34,480
Connecticut	442.214	263,782	107,226	50,346	475,010	200,642	1,024,450	514,770
Delaware	15,956	12,465	44,465	31,125	38,011	35,609	98,432	79,199
Florida	158,625	78,170	42,363	16,945	29,375	35,130	230,363	130,245
Georgia	30,265	31,366	45,756	42,615	168,446	148,767	244,467	222,748
Hawaii	42,242	47,577	9,040	8,625	95,694	134,503	146,976	190,705
Illinois	1,594,298	777,821	952,108	453,465	1,990,382	1,038,882	4,536,788	2,270,168
Indiana	1,424,110	783,336	317,455	118,486	180,159	103,858	1,921,724	1,005,680
Iowa	56,409	39,582	488,150	215,229	416,211	270,549	960,770	525,360
Kansas	232,399	143,595	584,395	275,373	219,090	165,168	1,035,884	584,136
Kentucky	551,399	374,010	784,021	349,714	230,995	141,412	1,566,415	865,136
Louisiana	....	....	9,700	7,615	27,600	21,666	37,300	29,281
Maine	1,386	1,524	11,358	9,180	20,656	16,242	33,400	26,946
Maryland	552,425	375,855	333,453	185,158	203,396	165,696	1,089,274	726,709
Massachusetts	588,648	526,590	17,448	13,048	816,330	573,571	1,422,426	1,113,209
Michigan	237,307	126,145	91,713	34,998	351,635	175,714	680,655	336,857
Minnesota	137,546	114,187	71,772	45,230	222,423	193,324	431,741	352,741
Missouri	515,382	411,831	296,099	176,101	579,942	459,319	1,391,423	1,047,251
Montana	14,681	10,265	490	245	2,291	751	17,462	11,261
Nebraska	12,040	9,610	2,500	1,950	226,205	200,318	240,745	211,878
New Hampshire	2,000	1,350	1,392	1,306	21,329	14,312	24,721	16,968
New Jersey	958,907	760,736	384,305	240,308	434,032	316,009	1,777,244	1,317,053
New Mexico	500	725	803,086	388,119	27,806	13,650	831,392	402,494
New York	2,735,105	1,664,897	1,590,242	753,966	1,983,097	1,294,978	6,308,444	3,713,841
North Carolina	63,169	61.493	59,514	26,808	82,549	77,154	205,232	165,455
Ohio	3,212,152	1,509,752	1,244,508	520,795	927,106	437,025	5,383,766	2,467,572
Oklahoma	21,950	16,850	682,523	383,550	243,557	146,637	948,030	547,037
Oregon	538.292	434,001	....	....	80,839	87,899	619,131	521,900
Pennsylvania	1,628,923	1,006,014	1,534,424	843,166	1,324,782	792,440	4,488,129	2,641,620
Rhode Island	25,028	33,616	....	....	16,054	20,496	41,082	54,112
South Carolina	18,839	18,039	2,416	1,045	106,265	110,000	127,520	129,084
South Dakota	2.275	1,450	400	100	32,389	25,746	35,064	27,296
Tennessee	519,688	406,448	210.534	90,444	148,698	80,904	878,920	577,796
Texas	124,240	91,171	406,881	175,386	181,888	151,633	713,009	418,190
Utah	4,480	1,680	....	....	20	5	4,500	1,685
Vermont	13,500	8,952	....	....	12,810	9,020	26,310	17,972
Virginia	109,963	83.582	609,049	293,856	212,292	146,077	931,304	523,515
Washington	229,193	138,183	2,755	1,874	1,330	2,378	233,278	142,435
West Virginia	14,483	10.627	835,979	400,163	109,627	63,977	960,089	474,767
Wisconsin	611,988,	336,773	99,836	44,143	540,649	268,650	1,252,473	649,566
Wyoming	....	....	....	....	22,840	18,383	22,840	18,383
Total	19,426,098	12,048,325	13,641,048	6,819,986	14,780,791	9,538,114	47,847,937	28,406,425

According to this table there were nine States that produced crushed stone valued at more than $1,000,000, as follows: New York, California, Pennsylvania, Ohio, Illinois, New Jersey, Massachusetts, Missouri, and Indiana.

The following table shows the quantity and value of crushed stone produced in the United States in 1910 and 1911 by uses and kinds of stone:

Quantity and value of crushed stone produced in the United States in 1910 and 1911, by kinds and uses, in short tons.

1910.

Kind.	Road making.		Railroad ballast.		Concrete.		Total.		Average price per ton.
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	
Granite......	2,280,574	$1,957,206	1,680,524	$876,192	1,617,062	$1,374,714	5,578,160	$4,208,112	$0.75
Trap rock...	4,494,714	3,104,353	1,756,003	983,370	2,945,748	1,897,185	9,196,465	5,984,908	.65
Limestone...	11,947,794	6,595,717	9,340,573	4,288,431	8,375,613	4,781,214	29,663,980	15,665,362	.53
Sandstone...	362,088	253,970	478,462	248,198	1,029,517	903,985	1,870,067	1,406,153	.75
Total..	19,085,170	11,911,246	13,255,562	6,396,191	13,967,940	8,957,098	46,308,672	27,264,535	....
Average price	....	$0.62	....	$0.48	....	$0.64	....	$0.59	....

1911.

Granite......	2,611,498	$1,883,748	1,653,848	$905,399	1,887,647	$1,557,400	6,152,993	$4,346,547	$0.71
Trap rock...	4,394,558	3,020,757	1,545,992	935,395	3,006,612	1,921,295	8,947,162	5,877,447	.66
Limestone...	12,075,515	6,886,855	9,708,418	4,619,972	8,664,508	5,041,530	30,448,441	16,548,357	.54
Sandstone...	344,527	256,965	732,790	359,220	1,222,024	1,017,889	2,299,341	1,634,074	.71
Total..	19,426,098	12,048,325	13,641,048	6,819,986	14,780,791	9,538,114	47,847,937	28,406,425	....
Average price	....	$0.62	....	$0.50	....	$0.65	....	$0.59	....

As shown by this table, the quantity and value of the crushed stone output in 1911 was 47,847,937 short tons, valued at $28,406,425, as compared with 46,308,672 short tons, valued at $27,264,535 in 1910, an increase of 1,539,265 tons in quantity and of $1,141,890 in value over the output in 1910. The average price per ton was 59 cents for both 1910 and 1911.

Crushed granite increased 574,833 tons in quantity and $138,435 in value. The average price per ton decreased from 75 cents in 1910 to 71 cents in 1911.

Crushed trap rock decreased 249,303 short tons in quantity and $107,461 in value. The average price per ton is reported to have been 66 cents, as compared with 65 cents in 1910.

Crushed limestone increased 784,461 short tons in quantity and $882,995 in value. The average price per ton increased from 53 cents in 1910 to 54 cents in 1911.

Crushed sandstone increased 429,274 short tons in quantity and $227,921 in value. The average price per ton was 75 cents in 1910 and 71 cents in 1911.

Crushed stone used for road making increased 340,928 short tons in quantity and $137,079 in value. The average price per ton was 62 cents in 1911, the same as in 1910.

Crushed stone for railroad ballast increased 385,486 short tons in quantity and $423,795 in value. The average price per ton increased from 48 cents in 1910 to 50 cents in 1911.

Crushed stone for concrete increased 812,851 short tons in quantity and $581,016 in value. The average price per ton increased from 64 cents in 1910 to 65 cents in 1911.

EXPORTS AND IMPORTS.

The following figures, compiled from statistics furnished by the Bureau of Statistics of the Department of Commerce and Labor, give the value of the exports and imports of stone for the calendar years 1910 and 1911:

Exports of stone from the United States in 1910 and 1911.

Kind.	1910	1911
Marble and stone, unmanufactured	$503,251	$674,134
All others	1,035,088	1,136,048
Total	[a] 1,538,339	[a] 1,810,182

[a] Includes exports of slate.

Imports of stone into the United States in 1910 and 1911.

Kind.	1910		1911	
	Quantity.	Value.	Quantity.	Value.
Marble:				
In block, rough, etc. . . . cubic feet	789,230	$934,328	624,735	$953,258
Sawed or dressed . . . cubic feet	446	958	353	603
Slabs or paving tiles . . . cubic feet	426,753	75,040	411,583	75,742
All other manufactures		220,489		200,265
Mosaic cubes (loose) . . . pounds	3,226,306	42,829	2,111,194	27,692
Total		1,273,644		1,257,560
Onyx:				
In blocks, rough, etc. . . . cubic feet	9,143	58,736	15,917	102,487
All other manufactures		1,537		1,412
Total		60,273		103,899
Granite:				
Dressed		172,121		143,523
Rough . . . cubic feet	11,912	4,791	14,688	2,945
Total		176,912		146,468
Stone (other):				
Dressed		12,296		18,400
Rough . . . cubic feet	95,181	46,018	61,986	30,071
Total		58,314		48,471
Grand total		1,569,143		1,556,398

These tables show an increase of $271,843 in the value of the exports of stone during 1911 and a decrease of $12,745 in the value of the imports.

GRANITE.

PRODUCTION.

The figures given in this report as representing the value of th granite production in the United States include also the values o small quantities of gneiss, mica schist, lava, tuff, trachyte, andesite syenite, quartz porphyry, basalt, and other igneous rocks. Th quantities of these allied rocks quarried are too small to tabulat separately, and also the production of the igneous rocks other tha granite would have to be concealed for certain States because ther are less than three producers reporting. The quarrying of trap rock consisting largely of basalt and diabase, in the States of Californi Connecticut, Massachusetts, northern Michigan, New Jersey, Ne

York, and Pennsylvania, represents, however, an industry sufficient by itself to make it advisable to tabulate this stone separately, and therefore its value is not included in the grand total of granite. The value of the granite produced in the United States in 1911 was $21,391,878, an increase of $849,911, or 4 per cent, as compared with $20,541,967, the value in 1910.

Rough granite for monumental work, granite sold dressed for monumental work, granite for paving blocks, crushed granite for roads, railroad ballast, and concrete, and granite for miscellaneous purposes not specified in the returns, increased in value; rough granite for building purposes, granite sold dressed for building purposes, and granite sold for rubble, riprap, curbing, and flagging showed a decrease. Fourteen States produced granite valued at more than $500,000 in 1911, in the following order: Vermont, Massachusetts, Maine, California, Wisconsin, Washington, New Hampshire, Rhode Island, Georgia, Maryland, Minnesota, North Carolina, Oregon, and Connecticut. Of these States the first seven produced granite valued at more than $1,000,000, and six of them, Vermont, Massachusetts, California, Washington, Rhode Island, and Connecticut showed an increase in value of output.

The following table shows the value of the production of granite, including a small output of other igneous rocks, in the United States from 1907 to 1911, inclusive:

Value of granite, etc., produced in the United States, by States and Territories, 1907–1911.

State or Territory.	1907	1908	1909	1910	1911
Alabama					(a)
Arizona	$13,700	$8,544	(a)	(a)	$13,105
Arkansas	168,996	152,567	$150,179	$226,690	354,041
California	1,306,324	1,634,504	1,310,520	1,529,299	1,738,094
Colorado	67,134	121,282	74,316	93,679	137,356
Connecticut	591,153	592,904	610,514	410,535	574,673
Delaware	158,192	195,761	456,328	357,708	218,234
District of Columbia					(a)
Georgia	858,603	970,832	843,542	1,049,186	847,023
Hawaii	19,599	81,219	63,955	139,724	339,519
Idaho	25,942	(a)	(a)	(a)	(a)
Maine	2,146,420	2,027,508	1,939,524	2,315,730	2,257,034
Maryland	1,183,753	762,442	771,224	982,746	845,936
Massachusetts	2,328,777	2,027,463	2,164,619	1,567,754	2,361,624
Michigan			b 660,823	b 858,734	
Minnesota	546,603	629,427			797,244
Missouri	136,405	157,968	155,717	120,663	139,070
Montana	102,050	(a)	(a)	(a)	29,670
Nevada				(a)	(a)
New Hampshire	647,721	867,028	1,215,461	1,230,656	1,017,272
New Jersey	75,757	125,804	60,175	80,105	167,112
New Mexico	167,294		(a)	(a)	(a)
New York	289,722	367,066	443,910	330,716	344,038
North Carolina	889,976	764,272	743,876	839,742	772,685
Oklahoma	24,550	23,239	67,584	102,566	20,244
Oregon	117,625	271,869	284,135	1,080,009	580,978
Pennsylvania	366,679	324,241	507 814	478,919	491,428
Rhode Island	674,148	556,474	933,053	521,490	957,743
South Carolina	129,377	297,874	218,045	369,448	193,748
South Dakota	690	(a)			(a)
Texas	122,158	190,055	173,271	66,909	70,488
Utah	5,240	5,229	7,525	6,783	5,209
Vermont	2,693,889	2,451,933	2,811,744	2,694,474	2,730,719
Virginia	398,426	321,530	488,250	503,106	420,611
Washington	562,352	870,944	742,878	642,992	1,345,551
Wisconsin	1,228,863	1,529,781	1,442,305	1,475,342	1,382,309
Wyoming	90	(a)			
Other States		40,320	c 235,300	d 466,262	e 239,120
Total	18,064,708	18,420,080	19,581,597	20,541,967	21,391,878

[a] Included in "Other States."
[b] Includes a small value for trap rock in Michigan and Minnesota.
[c] Includes Arizona, Idaho, Montana, and New Mexico.
[d] Includes Arizona, Idaho, Montana, Nevada, and New Mexico.
[e] Includes Alabama, District of Columbia, Idaho, Nevada, New Mexico, and South Dakota.

The following table shows the value of the granite, including small values for trap and other igneous rocks, produced in the United States in 1910 and 1911, by States and Territories and uses:

Value of granite and other igneous rocks in the United States in 1910 and 1911, by States and Territories and uses.

1910.

State or Territory.	Sold in the rough.					Dressed for building.	Dressed for monumental.	Made into paving blocks.
	Building.	Monumental.	Rubble.	Riprap.	Other.			
Arizona	....	....	....	....	....	....	....	....
Arkansas	....	$80	$1,612	$11,600	$75	$8,000	....	....
California	$67,132	42,380	62,649	48,113	103,327	278,091	$114,678	$28,925
Colorado	6,630	22,435	2,310	....	....	....	25,584	....
Connecticut	21,643	19,098	6,022	45,636	9,170	160,933	40,164	35,761
Delaware	5,461	....	....	238,435	....	1,227	....	7,818
Georgia	60,696	45,363	29,970	24,110	1,025	65,188	2,001	195,207
Hawaii	2,800	....	....	26,833	....	....	....	....
Idaho	....	....	....	....	....	....	....	....
Maine	299,070	90,194	36,846	36,681	7,730	954,513	200,105	548,374
Maryland	124,275	29,173	65,610	1,414	7,659	94,389	19,700	60,612
Massachusetts	202,375	461,814	16,703	20,631	78,761	349,431	32,600	201,425
Michigan	....	....	....	....	....	....	....	....
Minnesota	22,971	127,907	3,983	2,297	7,150	182,341	313,187	83,658
Missouri	1,958	34,719	....	3,367	....	5,292	5,800	28,889
Montana	....	....	....	....	....	....	....	....
Nevada	....	....	....	....	....	....	....	....
New Hampshire	101,672	64,321	6,046	4,881	3,064	576,271	153,373	233,836
New Jersey	6,772	750	480	850	1,715	1,338	....	400
New Mexico	....	....	....	....	....	....	....	....
New York	34,617	38,254	2,026	17,297	950	6,291	25,344	100,127
North Carolina	57,265	9,141	4,297	11,520	800	126,043	68,904	164,265
Oklahoma	3,770	7,943	4,530	1,600	400	66,792	12,386	720
Oregon	12,777	15,368	....	5,820	646,542	6,391	1,500	20,000
Pennsylvania	262,913	4,059	9,262	21,743	35,854	51,381	23,842	20,452
Rhode Island	16,439	166,306	152	26	610	43,140	185,079	40,411
South Carolina	20,499	77,864	1,755	5,035	46,200	15,950	46,724	....
Texas	11,219	30,090	....	3,600	....	....	....	....
Utah	420	5,000	....	....	....	1,088	275	....
Vermont	76,807	1,197,187	98	272	2,020	887,430	495,449	25,915
Virginia	31,841	3,771	38,792	6,989	2,375	14,750	6,300	28,596
Washington	5,976	2,945	62,092	4,598	121,557	28,910	49,246	58,986
Wisconsin	1,226	109,000	1,836	404	7,123	1,000	294,533	939,020
Other States[a]	3,909	700	....	....	....	220,000	3,925	375
Total	1,463,133	2,605,862	357,071	543,752	1,084,107	4,146,180	2,110,699	2,823,772

[a] Includes Arizona, Idaho, Montana, Nevada, and New Mexico.

Value of granite and other igneous rocks in the United States in 1910 and 1911, by States and Territories and uses—Continued.

1910—Continued.

State or Territory.	Curbing.	Flagging.	Crushed stone.			Other.	Total.
			Road making.	Railroad ballast.	Concrete.		
Arizona							(a)
Arkansas	$200		$177,457	$13,333	$14,333		$226,690
California	98,787	$500	393,611	139,406	120,802	$21,898	1,520,299
Colorado	1,320		26,600		8,800		93,679
Connecticut	33,809	2,189	14,880		19,717	1,513	410,535
Delaware	3,113		23,561	26,456	51,637		357,708
Georgia	290,555		10,555	79,153	245,315	48	1,049,186
Hawaii			33,502	825	75,764		139,724
Idaho							(a)
Maine	94,091	20,557	8,831	11,047	3,792	3,899	2,315,730
Maryland	2,210	3,065	330,977	70,690	136,380	46,592	982,746
Massachusetts	114,389	7,017	35,643	133	41,137	5,695	1,567,754
Michigan							(b)
Minnesota	14,404	105	53,181	16,530	24,777	6,243	c858,734
Missouri			21,110		19,528		120,663
Montana							(a)
Nevada							(a)
New Hampshire	60,369	2,282	861	611	17,729	14,340	1,239,656
New Jersey			8,775	45,943	12,206	876	80,105
New Mexico							(a)
New York	3,524	1,500	18,030	2,515	78,862	1,379	330,716
North Carolina	125,478	300	119,466	98,516	51,547	2,200	839,742
Oklahoma		3,000	75		1,000	350	102,566
Oregon	250		303,846		67,515		1,080,009
Pennsylvania	6,068		7,168	758	35,138	281	478,919
Rhode Island	11,530		32,136	3,919	21,742		521,490
South Carolina	3,860	200	49,977	23,009	78,375		369,448
Texas					22,000		66,909
Utah							6,783
Vermont	2,365		2,378	234	4,319		2,694,474
Virginia	57,511	1,565	40,691	53,761	211,444	4,720	503,106
Washington	84,141		192,916	350	12,864	18,411	642,992
Wisconsin	9,055	2,058	50,979		52,141	6,967	1,475,342
Other States d	2,500			230,953	3,900		466,262
Total	1,019,529	44,338	1,957,206	818,142	1,432,764	135,412	20,541,967

a Included in "Other States."
b Included in Minnesota.
c Includes a small value for trap rock for Michigan and Minnesota.
d Includes Arizona, Idaho, Montana, Nevada, and New Mexico.

Value of granite and other igneous rocks in the United States in 1910 and 1911, by States and Territories and uses—Continued.

1911.

State or Territory.	Sold in the rough—					Dressed for—		Made into paving blocks.
	Building.	Monumental.	Rubble.	Riprap.	Other.	Building.	Monumental work.	
Alabama								
Arizona	$3,050	$6,000		$2,130	$1,825	$100		
Arkansas	3,000	50	$36,769	115,400	68	750		
California	19,450	37,181	12,994	261,653	210	393,504	$61,690	$78,978
Colorado	14,685	16,997	3,760		1,200	52,750	27,000	
Connecticut	24,177	33,312	1,310	144,679	2,278	175,287	60,139	49,498
Delaware	7,160		343	125,462	684	342		1,883
District of Columbia								
Georgia	113,708	91,924	44,381	3,500	10,220	27,329	28,000	91,893
Hawaii	1,500	100	64		142,000			
Idaho								
Maine	263,105	44,181	12,500	1,967	10,467	1,274,048	68,399	467,398
Maryland	99,416	20,594	67,178	7,846		65,698	3,600	37,480
Massachusetts	365,464	373,764	93,170	105,753	104,865	607,358	4,600	432,600
Minnesota	4,543	86,813	29,131	23,742	3,160	251,353	261,913	63,045
Missouri	6,147	33,095		1,955	165	20,000	8,000	33,125
Montana	3,430	500	504			23,159	463	
Nevada								
New Hampshire	77,508	63,188	7,864	3,886	5,506	380,171	170,169	212,526
New Jersey	6,090	9,620	1,253	2,009	1,612	4,192		
New Mexico								
New York	11,619	10,770	1,496	43,737		43,190	10,419	
North Carolina	59,434	11,183	4,671	5,224	3,200	102,678	3,788	192,841
Oklahoma	2,120	11,570	490		1,000	3,500	1,064	
Oregon	1,030		10,121	6,000		8,400	19,368	12,000
Pennsylvania	265,343	14,224	18,081	12,052	23,106	83,158	94	17,842
Rhode Island	17,576	184,634	26		385	387,458	186,095	114,293
South Carolina				62,432				
South Dakota								
Texas	10,951	29,835		3,994		2,450	8,500	
Utah	320	3,549				50	1,290	
Vermont	54,552	1,290,807	2,537	7,875	1,033	795,083	543,508	27,177
Virginia	9,580	8,990	27,870	7,975	765	11,948	2,000	32,458
Washington	60,216	4,153	23,590	814,457	2,000	165,700	27,613	49,798
Wisconsin	7,526	104,111	451	2,761	105	689	275,116	872,878
Other States[a]	2,325	300		23,375			1,500	
Total	1,515,025	2,491,445	400,554	1,789,864	315,854	4,880,345	1,774,328	2,787,713

[a] "Other States" includes Alabama, District of Columbia, Idaho, Nevada, New Mexico, and South Dakota.

Value of granite and other igneous rocks in the United States in 1910 and 1911, by States and Territories and uses—Continued.

1911—Continued.

State or Territory.	Curbing.	Flagging.	Crushed stone.			Other.	Total.
			Road making.	Railroad ballast.	Concrete.		
Alabama							(*a*)
Arizona							$13,105
Arkansas			$7,000	$145,004	$46,000		354,041
California	$89,969	$350	361,255	138,448	278,378	$4,034	1,738,094
Colorado	1,200		17,764		2,000		137,356
Connecticut	27,269	1,058	43,279		12,298	89	574,673
Delaware	3,129		12,465	31,125	35,609	32	218,234
District of Columbia							(*a*)
Georgia	223,131		31,366	36,615	143,841	1,115	847,023
Hawaii	5,150		47,577	8,625	134,503		339,519
Idaho							(*a*)
Maine	77,386	6,246	1,524	9,180	16,242	4,391	2,257,034
Maryland	850	266	273,928	136,661	115,466	16,953	845,936
Massachusetts	144,785	1,586	76,515	870	47,918	2,376	2,361,624
Minnesota	9,166		27,781	10,446	16,659	9,492	797,244
Missouri	1,348		11,945		23,290		139,070
Montana	1,614						29,670
Nevada							(*a*)
New Hampshire	62,043	90	1,350	1,306	14,312	17,353	1,017,272
New Jersey			86,175	53,020	2,803	338	167,112
New Mexico							(*a*)
New York	5,534	800	87,428		128,595	450	344,038
North Carolina	210,943	4,977	45,915	26,808	77,129	23,894	772,685
Oklahoma	500						20,244
Oregon			434,001		87,899	2,159	580,978
Pennsylvania	10,122	55	22,958		24,393		491,428
Rhode Island	13,164		33,616		20,496		957,743
South Carolina	2,232		18,039	1,045	110,000		193,748
South Dakota							(*a*)
Texas	1,200				13,558		70,488
Utah							5,209
Vermont	1,400		1,177		5,570		2,730,719
Virginia	24,149	3,330	39,379	145,722	104,945	1,500	420,611
Washington	46,310	3,223	138,183	1,874	2,378	8,056	1,345,551
Wisconsin	9,540	2,659	63,128		43,118	227	1,382,309
Other States [b]	2,970			158,650	50,000		239,120
Total	975,104	24,640	1,883,748	905,399	1,557,400	90,459	21,391,878

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[a] Included in "Other States."

[b] "Other States" includes Alabama, District of Columbia, Idaho, Nevada, New Mexico, and South Dakota.

The following table shows the quantity and value of granite paving blocks produced in the United States in 1910 and 1911, by States:

Number and value of granite paving blocks produced in 1910 and 1911, by States and Territories.

State.	Paving blocks.			
	1910		1911	
	Number.	Value.	Number.	Value.
Arizona	8,000	$375		
California	698,740	28,925	1,526,143	$78,978
Connecticut	786,762	35,761	1,038,474	49,498
Delaware	126,715	7,818	40,393	1,883
Georgia	4,966,493	195,207	2,819,788	91,893
Maine	10,893,020	548,374	10,040,523	467,398
Maryland	1,035,830	60,612	664,666	37,480
Massachusetts	4,532,685	201,425	9,000,073	432,600
Minnesota	1,223,000	83,658	933,000	63,045
Missouri	747,581	28,889	722,650	33,125
New Hampshire	6,772,224	233,836	5,613,841	212,526
New Jersey	8,000	400		
New York	1,251,950	100,127		
North Carolina	3,499,497	164,265	4,953,101	192,841
Oklahoma	18,000	720		
Oregon	500,000	20,000	300,000	12,000
Pennsylvania	466,296	20,452	427,238	17,842
Rhode Island	868,088	40,411	1,493,887	114,293
Vermont	826,071	25,915	915,766	27,177
Virginia	680,602	28,596	872,710	32,458
Washington	1,083,065	58,986	1,145,975	49,798
Wisconsin	15,996,780	939,020	15,610,875	872,878
Total	57,089,399	2,823,772	58,119,103	2,787,713
Average price per thousand		$49.46		$47.97

This table shows an increase in quantity of 1,029,704 blocks and a decrease in value of $36,059 for the granite paving blocks cut in the United States in 1910. A large proportion of the output of Wisconsin, the largest producing State, goes to Chicago; the blocks for New York and other large eastern cities are supplied by Massachusetts, Maine, New York, North Carolina, New Hampshire, New Jersey, Georgia, and other granite-producing States near the Atlantic seaboard; and the Pacific coast demand is met by the quarries in the States situated on that coast. The average price per thousand at the original points of shipment was $47.97 in 1911, a decrease of $1.49 as compared with the price in 1910.

GRANITE PRODUCTION OF VERMONT.

A more detailed statement of the granite production of Vermont is of interest here, as Vermont at present produces more granite than any other State and as the granite industry is one of the principal sources of its wealth.

The following table shows the production of granite in Vermont in 1910 and 1911, by counties and uses:

Production of granite in Vermont in 1910 and 1911, by counties and uses.

County.	Number of firms reporting.	Building.				Monumental.				Paving.		Other uses.	Total value.
		Rough.		Dressed.		Rough.		Dressed.					
		Quantity (cubic feet).	Value.	Quantity (cubic feet).	Value.	Quantity (cubic feet).	Value.	Quantity (cubic feet).	Value.	Quantity (number of blocks).	Value.	Value.	
1910.													
Washington and Orange	28	37,012	$22,446	246,969	$887,430	1,215,194	$1,120,843	134,459	$481,249	550,871	$14,050	$10,682	$2,121,456
Windsor	3	31,403	26,371										441,615
Caledonia, Essex, and Orleans	10	51,026	20,635	....	....	143,650	76,200	7,200	14,200	....	....	666	111,701
Windham	3	15,153	7,355	....	....	145	144	....	....	275,200	11,865	338	19,702
Total	44	134,594	76,807	246,969	887,430	1,358,989	1,197,187	141,659	495,449	826,071	25,915	11,686	2,694,474
Average price per cubic foot	....	....	$0.57	....	$3.60	....	$0.88	....	$3.50		Per M. 31.37	....	....
1911.													
Washington and Orange	29	32,463	$24,785	180,225	$783,518	1,282,582	$1,229,553	144,789	$513,548	777,266	$21,510	$19,200	$2,058,389
Windsor	3	5,500	7,400										541,125
Essex and Orleans	5	35,900	8,950	10,050	7,000	62,000	27,800	1,000	1,000	....	....	240	44,990
Windham	3	7,421	3,117	1,015	2,565	7,530	3,171	....	....	138,500	5,667	152	14,672
Caledonia	8	23,000	10,300	1,000	2,000	65,016	30,283	11,000	28,960	....	....	....	71,543
Total	48	104,284	54,552	192,290	795,083	1,417,128	1,290,807	156,789	543,508	915,766	27,177	19,592	2,730,719
Average price per cubic foot	....	....	$0.52	....	$4.13	....	$0.91	....	$3.47		Per M. 29.68	....	....

The most noteworthy change in value is the average value per cubic foot reported for dressed building granite, which was 53 cents higher than that reported for 1910.

GRANITE PRODUCTION OF MAINE.

A detailed statement of the granite production of Maine is herewith presented for the first time. The granite industry is one of the principal sources of the wealth of the State.

The low price per cubic foot of the stone reported as sold for rough building purposes is accounted for by the fact that the large stone quarries of Hancock and York counties are directly on the coast, which lessens the cost of stone at the shipping point. Large quantities of this stone are used for the construction of bridge masonry and other heavy construction work in New York City and vicinity.

The following table shows the output of granite in Maine in 1911, by counties and uses:

Production of granite in Maine in 1911, by counties and uses.

County.	Number of operators.	Building.				Monumental.				Paving.		Crushed stone.		Curbing and flagging.		Other.	Total value.
		Rough.		Dressed.		Rough.		Dressed.									
		Quantity (cubic feet).	Value.	Quantity (cubic feet).	Value.	Quantity (cubic feet).	Value.	Quantity (cubic feet).	Value.	Quantity (number of blocks).	Value.	Quantity (short tons).	Value.	Quantity (lineal feet).	Value.	Value.	
Cumberland	6	1,800	$1,352	300	$510	2,676	$2,676	175	$358	....	....	2,205	$2,445	5,000	$2,000	$130	$9,471
Franklin and Oxford	7	89,379	37,685	268,998	601,682	2,241	1,180	60	317	694,464	$29,038	29,273	23,033	8,406	1,685	7,354	701,974
Hancock	36	968,505	183,222	88,053	114,555	925	278	2,908	3,592	3,040,898	141,166	114	125	176,788	76,754	11,519	531,211
Kennebec and Waldo	4	57,637	20,901	228,918	509,441	8,905	5,725	9,240	33,000	369,000	14,760	....	....	....	....	1,052	584,879
Knox and Lincoln	9	8,755	3,700	13,194	35,564	29,289	18,854	5,071	15,309	5,580,965	267,726	....	....	2,190	721	4,196	345,800
Somerset	4	902	451	8,100	3,000	11,435	5,718	600	500	255,196	10,208	1,790	1,343	4,050	810	....	21,830
Washington and Aroostook	10	7,628	4,762	879	3,680	8,840	9,035	3,522	13,207	100,000	4,500	....	....	....	....	....	35,184
York	6	62,304	11,032	1,607	5,613	1,208	715	980	2,586	....	....	....	....	4,165	1,662	5,074	26,685
Total	82	1,196,910	263,105	609,049	1,274,018	65,519	44,181	22,556	68,869	10,040,523	467,398	33,382	26,946	200,599	83,632	29,325	2,257,034
Average price	....	....	$0.22	....	$2.09	....	$0.67	....	$3.03	Per M.	$46.55	....	$0.81	....	$0.42	....	....

TRAP ROCK.

Besides the trap rock reported in the following tables there is a small quantity included in the figures for granite under those States in which trap rock does not form enough of an industry to warrant the separate publication of the figures. The trap-rock industry in the Pacific coast States is known as the basalt-quarrying industry.

In the value of trap rock produced in Massachusetts is included the value of the slate quarried in the vicinity of Boston. The lack of fissility of this rock renders it unsuitable for any of the purposes for which slate is used; therefore it is crushed and used entirely for road making.

The total output of trap rock in 1911 was valued at $6,399,622 as compared with $6,452,141 in 1910, a decrease of $52,519. California and Massachusetts were the only States showing increases in value of production. Crushed stone for concrete increased in value, and also stone used for other purposes, which includes riprap, rubble, etc. The value of all other products decreased.

California, in 1911 as in 1910, showed the largest value of trap-rock products. New Jersey ranked second.

The following table shows the value of the trap production in the United States in 1910 and 1911, by States and uses:

Value of trap rock produced in the United States in 1910 and 1911, by States and uses.

1910.

State.	Building.	Paving.	Crushed stone.			Other.	Total.
			Road making.	Railroad ballast.	Concrete.		
California	$1,630	$163,897	$710,688	$154,449	$820,958	$103,713	$1,955,335
Connecticut	8,321	332	228,981	109,616	147,711	5,268	500,229
Massachusetts	19,630		374,448	81,729	310,230	11,011	797,048
New Jersey	7,939	60,976	721,761	223,817	229,906	13,263	1,257,712
New York	20,377		780,060	8,660	144,806	17,091	970,994
Pennsylvania	29,885	440	288,415	405,099	243,574	3,410	970,823
Total	87,832	225,645	3,104,353	983,370	1,897,185	153,756	6,452,141

1911.

State.	Building.	Paving.	Road making.	Railroad ballast.	Concrete.	Other.	Total.
California	$4,077	$156,242	$699,543	$311,019	$688,926	$186,123	$2,055,930
Connecticut	8,402	2,695	220,180	50,346	187,234	3,604	472,461
Massachusetts	13,825		384,115	12,178	442,113	6,839	859,070
Northern Michigan			12,571		38,429		51,000
New Jersey	6,154	26,441	646,209	177,019	271,203	9,359	1,136,385
New York	22,250		704,566	63,500	133,650	36,000	959,966
Pennsylvania	27,122	2,100	353,573	321,333	159,740	942	864,810
Total	81,830	197,478	3,020,757	935,395	1,921,295	242,867	6,399,622

The following table shows the quantity and value of trap paving blocks produced in the United States in 1910 and 1911, by States:

Number and value of trap paving blocks produced in the United States, 1910–11, by States.

State.	Paving blocks.			
	1910		1911	
	Number.	Value.	Number.	Value.
California	3,891,443	$163,897	3,501,000	$166,242
Connecticut	9,475	332	69,875	2,695
New Jersey	2,114,117	60,976	913,678	26,441
Pennsylvania	11,000	440	50,000	2,100
Total	6,026,035	225,645	4,534,553	197,478
Average price per thousand		37.47		43.55

SANDSTONE.

PRODUCTION.

Total value.—The value of sandstone decreased from $7,930,019 in 1910 to $7,730,868 in 1911, or $199,151. The leading sandstone-producing States in 1911 were New York, Ohio, and Pennsylvania, in the order named. Of these, Ohio and Pennsylvania showed a decrease in production. Among the decreases in 1911 which were notable in proportion to the total output for 1910 were those of Arizona, Michigan, Minnesota, Missouri, Montana, Oregon, and Texas. In Iowa, New Mexico, and Oklahoma there were proportionately large increases in the value of the sandstone production.

In New York and Pennsylvania a part of the sandstone output is known to the trade as bluestone, the production of which is given also in a separate table.

The following table shows the value of the sandstone production in the United States from 1907 to 1911, inclusive, by States:

Value of sandstone (including quartzite) production in the United States, 1907–1911, by States.

State.	1907	1908	1909	1910	1911
Alabama	$48,673	$34,099	$77,327	$109,063	$73,195
Arizona	158,435	396,358	298,335	131,716	[a] 57,100
Arkansas	94,275	42,463	67,956	71,641	85,529
California	437,738	330,214	290,034	113,488	176,213
Colorado	299,443	181,051	197,105	189,603	135,673
Connecticut	(b)	55,949	(c)	(c)	(c)
Florida	....	....	....	....	(d)
Idaho	24,001	33,394	29,263	34,070	40,097
Illinois	14,996	12,218	26,891	5,710	30,953
Indiana	15,425	3,342	4,119	4,141	7,078
Iowa	3,542	2,337	2,443	14,456	56,312
Kansas	46,831	67,950	19,560	25,691	13,774
Kentucky	98,450	78,732	90,835	90,729	97,439
Maryland	13,859	6,262	10,584	18,226	10,097
Massachusetts	243,323	241,462	[e] 457,962	[e] 424,485	[e] 406,072
Michigan	53,003	39,103	36,084	31,233	12,985
Minnesota	300,204	197,184	299,358	483,578	292,366
Missouri	35,289	17,954	28,763	39,398	19,748
Montana	39,216	51,564	73,443	59,019	34,437
Nebraska	11,609	[f] 15,815	....	....	(g)
Nevada	....	(h)	(g)	(q)	....
New Jersey	177,667	154,422	189,098	112,650	155,765
New Mexico	12,450	[j] 10,410	4,963	1,402	4,085
New York	[k e] 1,978,117	[k] 1,774,843	[k] 1,430,830	[k] 1,810,770	[k] 2,353,995
North Carolina	4,105	[l] 12,266	....	....	[m] 10,385
North Dakota	3,260	(n)	(o)	(p)	....
Ohio	1,591,148	1,244,752	1,639,006	1,402,131	1,334,947
Oklahoma	43,403	57,124	59,855	19,801	90,971
Oregon	3,904	(n)	[j] 4,811	[j] 30,375	[q] 1,668
Pennsylvania	[k] 2,064,913	[k] 1,368,784	[k] 1,637,794	[k] 1,595,070	[k] 1,333,309
South Dakota	143,585	128,554	[r] 118,029	156,576	141,615
Tennessee	16,523	(s)	(p)	(p)	(s)
Texas	108,047	154,948	61,600	40,471	28,000
Utah	24,298	25,097	71,235	43,589	41,953
Virginia	(p)	(s)	28,574	25,080	31,315
Washington	295,585	464,587	335,470	438,581	301,843
West Virginia	[t] 197,926	127,149	[m] 201,038	[u] 212,308	203,935
Wisconsin	236,183	219,130	204,959	189,654	144,430
Wyoming	32,252	44,574	13,130	5,314	3,584
Total	8,871,678	7,594,091	8,010,454	7,930,019	7,730,868

[a] Includes Florida.
[b] Included in New York.
[c] Included in Massachusetts.
[d] Included in Arizona.
[e] Includes Connecticut.
[f] Includes North Dakota and Oregon.
[g] Included in Oregon.
[h] Included with New Mexico.
[j] Includes Nevada.
[k] Includes bluestone.
[l] Includes Tennessee and Virginia.
[m] Includes Tennessee.
[n] Included with Nebraska.
[o] Included in South Dakota.
[p] Included in West Virginia.
[q] Includes Nebraska.
[r] Includes North Dakota.
[s] Included with North Carolina.
[t] Includes a small value for Virginia.
[u] Includes Tennessee and North Carolina.

The following table shows the value of the sandstone, including quartzite, production of the United States in 1910 and 1911, by States and uses:

Value of sandstone (including quartzite) production in the United States in 1910 and 1911, by States and uses.

1910.

State.	Rough building.	Dressed building.	Ganister.	Paving.	Curbing.	Flagging.	Rubble.
Alabama	$100		$12,088				$20,802
Arizona	4,900	$52,188			$50		41,000
Arkansas	3,944	225		$341	7,680	$265	235
California	29,177	32,825			3,185	1,400	265
Colorado	44,531	23,133	40,700	18,566	11,591	6,053	17,660
Connecticut							
Idaho	19,318	11,353					3,376
Illinois	1,770		2,500	500		600	340
Indiana	2,300	780			100	136	
Iowa	1,279	101					17
Kansas	14,016			8,500	60	2,400	265
Kentucky	20,593	59,967		450		1,000	
Maryland	1,733		7,966	2,700			2,657
Massachusetts	168,802	44,911			3,824		21,723
Michigan	13,312	15,416					2,505
Minnesota	4,215	34,139		323,267	32,108	925	24,935
Missouri	5,123	5,830			560	122	2,863
Montana	3,999	26,949					5,820
Nevada							
New Jersey	56,099	16,600			350	1,400	1,800
New Mexico	335	250		100			67
New York	118,296	313,101		348,502	322,643	174,489	50,626
North Carolina							
Ohio	195,950	404,588	160	1,733	313,749	329,594	30,761
Oklahoma	10,580	4,326		1,016	21	616	2,670
Oregon	22,605	1,000		6,120			
Pennsylvania	292,751	281,020	274,645	24,917	159,903	117,727	101,240
South Dakota	24,907	23,379		80,140	1,150		8,760
Tennessee							
Texas	140	38			1,015		4,500
Utah	16,989	980		2,728			17,601
Virginia		530					2,800
Washington	46,783	145,370		79,430	20,450		9,751
West Virginia	29,410	67,706		585	3,463	638	23,505
Wisconsin	17,165	35,751	66,138			11,714	5,675
Wyoming	3,754	1,560					
Total	1,174,876	1,604,016	404,197	899,595	881,902	649,079	404,219

Value of sandstone (including quartzite) production in the United States in 1910 and 1911, by States and uses—Continued.

1910—Continued.

State.	Riprap.	Crushed stone.			Other.	Total.
		Road making.	Railroad ballast.	Concrete.		
Alabama	$20,073			$56,000		$109,063
Arizona	24		$5,000	23,554	$5,000	131,716
Arkansas	36,888	$4,762	4,749	12,327	225	71,641
California	753	5,500	35,000	5,350	33	113,488
Colorado	1,025		7,500	17,674	1,170	189,603
Connecticut						([a])
Idaho					23	34,070
Illinois						5,710
Indiana	825					4,141
Iowa	9,000			4,029	30	14,456
Kansas				100	350	25,691
Kentucky	919			5,000	2,800	90,729
Maryland	20			3,150		18,226
Massachusetts	6,695	47,276		125,310	5,944	[b] 424,485
Michigan						31,233
Minnesota	4,870	34,098	6,811	17,887	323	483,578
Missouri	21,355			525	3,020	39,398
Montana	16,995				5,256	59,019
Nevada						([c])
New Jersey	200	9,191		27,010		112,650
New Mexico	650					1,402
New York	44,744	21,508	2,290	400,742	13,829	[d] 1,810,770
North Carolina						([e])
Ohio	38,246	13,844		47,333	26,173	1,402,131
Oklahoma	216			108	248	19,801
Oregon	150	500				[f] 30,375
Pennsylvania	31,872	111,557	123,741	57,305	18,392	[d] 1,595,070
South Dakota	7,191	241		8,388	2,420	156,576
Tennessee						([e])
Texas	7,015			27,650	113	40,471
Utah	5,291					43,589
Virginia		1,500	18,000	2,250		25,080
Washington	11,303				125,494	438,581
West Virginia	10,401	100	45,107	31,277	116	[g] 212,308
Wisconsin	17,677	3,893		31,016	625	189,654
Wyoming						5,314
Total	294,398	253,970	248,198	903,985	211,584	7,930,019

[a] Included in Massachusetts.
[b] Includes Connecticut.
[c] Included in Oregon.
[d] Includes bluestone.
[e] Included in West Virginia.
[f] Includes Nevada.
[g] Includes North Carolina and Tennessee.

Value of sandstone (including quartzite) production in the United States in 1910 and 1911, by States and uses—Continued.

1911.

State.	Rough building.	Dressed building.	Ganister.	Paving.	Curbing.	Flagging.	Rubble.
Alabama			$12,700				$14,362
Arizona	$2,000	$1,300					
Arkansas	5,375	525		$80	$10,450	$253	1,958
California	25,534	613			39,518	52,610	33,480
Colorado	26,526	26,268	24,320	20,474	9,690	4,088	8,591
Idaho	32,015	6,260					1,802
Illinois	1,020	180	2,200	150			155
Indiana	500	5,390			210	90	
Iowa	875	162			19		27
Kansas	8,478	605		980	807	876	178
Kentucky	35,048	56,413				2,160	211
Maryland	3,751		398				
Massachusetts	185,336	42,940					20,657
Michigan	5,682	2,809					3,068
Minnesota	5,279	31,237		184,796	25,928		13,073
Missouri	2,800	9,804					1,792
Montana	500	25,745					3,597
New Jersey	60,716	45,900				750	
New Mexico	2,150	1,125					50
New York	158,564	273,978		297,670	474,345	274,125	17,210
North Carolina	375	7,700					1,985
Ohio	125,596	341,252	3,843	1,294	381,463	320,840	8,170
Oklahoma	4,766		36				7,654
Oregon	138			1,000			506
Pennsylvania	203,989	218,153	163,574	35,872	172,202	93,812	102,788
South Dakota	18,878	29,325		59,382			3,445
Texas	50	1,400			550		1,250
Utah	13,705	22,248		1,881	274		3,845
Virginia	1,000	4,500					2,550
Washington	154	77,472		78,706			73,968
West Virginia	11,601	79,988			9,304		35,128
Wisconsin	25,605	32,492	40,548	7,541			11,060
Wyoming	2,950	334					300
Total	970,956	1,346,118	247,619	689,826	1,124,760	749,604	372,860

State.	Riprap.	Road making.	Railroad ballast.	Concrete.	Other.	Total value.
Alabama	$16,133			$30,000		$73,195
Arizona		$5,670	$6,000	32,130		[a] 57,100
Arkansas	33,172	9,627	8,086	15,482	$521	85,529
California	570	5,753	39	13,739	4,357	176,213
Colorado	1,107	3,000		11,466	143	135,673
Connecticut						(b)
Florida						(c)
Idaho	20					40,097
Illinois		27,238			10	30,953
Indiana	880	8				7,078
Iowa		86	52,525	2,613	5	56,312
Kansas	150	700		650	350	13,774
Kentucky	46			2,950	611	97,439
Maryland		230	100	3,000	2,618	10,097
Massachusetts	7,110	65,960		83,540	529	[d] 406,072
Michigan	1,140				286	72,985
Minnesota	385	23,000	7,764	904		292,366
Missouri	4,010	17		350	975	19,748
Montana	2,631				1,964	34,437
Nebraska						(e)
New Jersey		16,736		31,663		155,765
New Mexico		725			35	4,085
New York	80,207	16,624	10,605	568,975	181,692	[f] 2,353,995
North Carolina				25	300	[g] 10,385
Ohio	90,317	4,598	150	38,801	18,623	1,334,947
Oklahoma	500		78,000		15	90,971
Oregon	18				6	[h] 1,668
Pennsylvania	34,328	69,271	130,895	98,010	10,415	[f] 1,333,309
South Dakota	8,139	1,200	100	20,746	400	141,615
Tennessee						(i)
Texas	750			24,000		28,000
Utah			21,250			41,953
Virginia		1,560		455		31,315
Washington	71,543					301,843
West Virginia	8,408	1,262	43,706	14,015	523	203,935
Wisconsin	8,459	3,700		14,375	650	144,430
Wyoming						3,584
Total	370,023	256,965	359,220	1,017,889	225,028	7,730,868

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[a] Includes Florida.
[b] Included in Massachusetts.
[c] Included in Arizona.
[d] Includes Connecticut.
[e] Included in Oregon.
[f] Includes bluestone.
[g] Includes Tennessee.
[h] Includes Nebraska.
[i] Included in North Carolina.

Building stone.—Sandstone for building, including rough and dressed stone, decreased in value from $2,778,892 in 1910 to $2,317,074 in 1911, a decline of $461,818. Ohio, Pennsylvania, and New York produced the most building stone.

Ganister.—Ganister, reported from Pennsylvania, Wisconsin, Colorado, Alabama, Ohio, Illinois, Maryland, and Oklahoma, was valued at $247,619 in 1911, a decrease of $156,578 over 1910.

Paving.—The total value of the paving stone decreased $209,769, from $899,595 in 1910 to $689,826 in 1911. New York and Minnesota were large producers.

Curbing.—Sandstone for curbing was valued at $881,902 in 1910; in 1911 its value was $1,124,760, an increase of $242,858. New York, Ohio, and Pennsylvania were the principal producers.

Flagging.—Ohio, New York, and Pennsylvania were the chief States producing sandstone flagging. Ohio and Pennsylvania declined in production and New York increased, the total increase in the United States amounting to $100,525, from $649,079 in 1910 to $749,604 in 1911.

Rubble.—Rubble decreased in value $29,359, from $404,219 in 1910 to $374,860 in 1911.

Riprap.—Sandstone sold for riprap increased in value from $294,398 in 1910 to $370,023 in 1911, a gain of $75,625.

Crushed stone.—There was an increase in value in crushed sandstone of $227,921, from $1,406,153 in 1910 to $1,634,074 in 1911. The quantity increased from 1,870,067 short tons in 1910 to 2,299,341 tons in 1911, a gain of 429,274 tons. The average price per ton in 1910 was 75 cents; in 1911 it was 71 cents.

BLUESTONE.

The rock popularly known as "bluestone" in southern New York and northeastern Pennsylvania is a fine-grained, compact, dark blue-gray argillaceous sandstone. Logically its production should be included under sandstone in this report, but since the quarrying of this material in the locality mentioned forms a more or less distinct industry its value is given separately. Because of the peculiar method of quarrying bluestone, it has been found that the best figures of production are obtained from the dealers who buy the stone from the numerous small quarrymen, mostly farmers, who get out this stone at intervals. The dealers usually quarry for themselves also, and are better able to give the entire quantity of stone bought and sold than are the small producers. The principal channels to market for this stone are the Erie Railroad, the New York, Ontario & Western Railway, and Hudson River. The output of bluestone increased in value from $1,535,187 in 1910 to $1,876,473 in 1911, or $341,286. The stone used for building decreased in value, but that reported as disposed of for flagging, curbing, and as crushed stone and for unspecified purposes showed a large increase.

The increase in value of bluestone produced in New York in 1911 as in 1910 was caused by the quarrying of a large quantity of bluestone in Ulster County that was used as rubble and as crushed stone in concrete in the building of dams for the New York City water-supply system. If it had not been for this fact the New York production, as well as that of Pennsylvania, would have decreased.

The following table shows the value and uses of the bluestone produced in New York and Pennsylvania in 1910 and 1911:

Value and uses of bluestone produced in New York and Pennsylvania in 1910 and 1911.

State.	Building purposes.	Flagging.	Curbing.	Crushed stone.	Other purposes.	Total value.
1910.						
New York	$380,453	$164,061	$213,584	$308,101	$68,996	$1,135,195
Pennsylvania	138,207	107,846	98,558	47,823	7,558	399,992
Total	518,660	271,907	312,142	355,924	76,554	1,535,187
1911.						
New York	$336,157	$273,860	$336,779	$395,676	$249,110	$1,591.582
Pennsylvania	92,493	87,769	78,106	17,233	9,290	284,891
Total	428,650	361,629	414,885	412,909	258,400	1,876,473

LIMESTONE.

PRODUCTION.

Total value.—This report does not include the value of stone burned into lime and put on the market and sold as lime, except in cases where the stone is quarried by manufacturing plants and ultimately burned into lime and used in the manufacturing process. This applies especially to stone quarried by sugar factories and alkali works, which make no accounting for the lime, but measure the stone quarried. A large quantity of limestone used in the manufacture of Portland cement is also excluded from these figures; the value of this stone enters into and is included in the value of the cement.

The commercial output of lime is given in another chapter of Mineral Resources.

The total value of limestone produced in 1911 was $33,897,362, as compared with $34,603, 678 in 1910, a decrease of $706,316. The decrease in value was chiefly in limestone used for fluxing, although there was some decrease in the value of rough and dressed building stone, curbing, flagging, rubble, and sugar-factory stone, and an increase in stone used for paving, riprap, crushed stone, and stone not classified.

The principal States that produced limestone in 1911 were, in rank of value, Pennsylvania, Ohio, Indiana, Illinois, New York, and Missouri, each reporting over $2,000,000. In each of these States except Ohio and New York, there was a decrease.

The following table shows the value of limestone, by States, from 1907 to 1911, inclusive:

Value of limestone from 1907 to 1911, by States and Territories.

State or Territory.	1907	1908	1909	1910	1911
Alabama	$694,699	$479,730	$700,642	$714,516	$571,798
Arizona	64,975	[a] 50,130	(b)	(b)	8,676
Arkansas	52,207	61,971	112,468	84,280	[c] 136,007
California	177,333	237,320	283,869	590,990	576,701
Colorado	502,751	378,822	355,136	415,523	341,798
Connecticut	1,476	[d] 3,727	[d] 5,023	[e] 9,062	[e] 21,040
Florida	15,000	41,910	[c] 49,856	[c] 84,457	97,520
Georgia	22,278	8,495	34,593	24,236	21,632
Hawaii			(f)		
Idaho	15,900	36,000	(f)	19,423	[g] 19,497
Illinois	3,774,346	3,122,552	4,234,927	3,847,715	3,436,977
Indiana	3,624,126	3,643,261	3,749,239	4,472,241	4,406,577
Iowa	560,582	530,945	525,277	543,600	679,895
Kansas	813,748	403,176	892,335	768,739	789,448
Kentucky	891,500	810,190	903,874	978,809	1,124,170
Louisiana			(h)	(h)	(i)
Maine	1,350	(j)	(j)	(j)	(j)
Maryland	142,825	128,591	197,939	154,370	218,636
Massachusetts	1,837	1,950		(j)	(j)
Michigan	760,333	669,017	750,589	842,126	1,001,535
Minnesota	735,319	667,095	698,309	654,833	612,915
Missouri	2,153,917	2,130,136	2,111,283	2,360,604	2,179,767
Montana	124,690	134,595	154,064	169,836	148,126
Nebraska	312,630	330,570	293,830	338,731	263,459
Nevada					(k)
New Jersey	274,452	172,000	224,017	224,709	138,148
New Mexico	193,732	(l)	[m] 140,801	[m] 227,657	243,119
New York	2,898,520	2,584,559	2,622,353	2,813,476	2,857,797
North Carolina	22,328	(n)	(n)	(n)	30,278
Ohio	3,566,822	3,519,557	4,020,046	4,357,432	4,461,882
Oklahoma	189,568	257,066	450,055	509,344	594,664
Oregon	5,750	6,230		3,594	(k)
Pennsylvania	5,821,275	4,057,471	5,073,825	5,394,611	5,242,795
Rhode Island	750	(j)	(j)	(j)	(j)
South Carolina				(n)	(n)
South Dakota	11,600	(o)	[p] 49,328	17,150	6,250
Tennessee	385,450	[q] 535,882	[q] 589,949	[r] 747,162	[s] 798,369
Texas	267,757	314,571	341,528	447,239	490,289
Utah	306,344	253,088	169,760	389,603	168,145
Vermont	23,126	20,731	18,839	25,250	19,702
Virginia	362,062	280,542	342,656	471,903	369,872
Washington	62,317	31,660	38,269	36,186	32,478
West Virginia	855,941	645,385	864,332	841,064	902,077
Wisconsin	1,027,095	1,102,009	1,047,044	979,522	848,363
Wyoming	18,920	[t] 31,168	24,346	43,687	36,960
Total	31,737,631	27,682,002	32,070,401	34,603,678	33,897,362

[a] Includes New Mexico.
[b] Included in New Mexico.
[c] Includes Louisiana.
[d] Includes Maine and Rhode Island.
[e] Includes Maine, Massachusetts, and Rhode Island.
[f] Included in South Dakota.
[g] Includes Nevada and Oregon.
[h] Included in Florida.
[i] Included with Arkansas.
[j] Included with Connecticut.
[k] Included with Idaho.
[l] Included with Arizona.
[m] Includes Arizona.
[n] Included with Tennessee.
[o] Included with Wyoming.
[p] Includes Hawaii and Idaho.
[q] Includes North Carolina.
[r] Includes North Carolina and South Carolina.
[s] Includes South Carolina.
[t] Includes South Dakota.

The following table shows the value of limestone produced in the United States in 1910 and 1911, by States and Territories and uses:

Value of the production of limestone in the United States in 1910 and 1911, by States and uses.

1910.

State.	Rough building.	Dressed building.	Paving.	Curbing.	Flagging.	Rubble.	Riprap.
Alabama	$1,901	$34,001	$4,500				$37,505
Arizona							
Arkansas	25,671	24,149				$910	
California	969	102					
Colorado							
Connecticut	1,614						
Florida		4,000				5,000	20,678
Georgia	548					817	
Idaho							
Illinois	50,958	9,963	128,413	$1,050	$825	236,315	48,315
Indiana	1,170,564	2,100,140	1,675	65,833	2,037	23,656	10,344
Iowa	76,147	9,687	3,119	225	1,110	42,278	57,334
Kansas	47,856	83,785	59,815	1,666	2,168	18,667	40,637
Kentucky	107,676	58,700	8,298	26,510	161	8,059	29,695
Louisiana							
Maine							
Maryland	4,944	1,322	384				
Massachusetts							
Michigan	3,552		35,500			2,205	908
Minnesota	127,822	137,710	1,480	4,625	6,386	59,421	28,557
Missouri	129,837	443,524	10,700	5,873	8,244	271,599	194,504
Montana	8,270			117		290	
Nebraska	1,892	19,643	23,858	5,500		3,939	43,065
New Jersey	1,540					735	
New Mexico	200						1,400
New York	95,303	42,568	16,492	1,575	750	44,235	24,115
North Carolina							
Ohio	55,942	3,230	300	982		26,512	433,007
Oklahoma	76,375	475	50,030	18,686	160	3,318	17,772
Oregon			2,000				
Pennsylvania	103,295	118	67,069	1,850	1,108	3,314	1,714
Rhode Island							
South Carolina							
South Dakota	2,200						
Tennessee	9,404	6,555	13,043	3,555	1,400	4,274	75,176
Texas	46,573	1,660		327	1,302	2,362	96,647
Utah	50,668	500				400	133,000
Vermont	3,440		180	150		2,500	
Virginia	125		45	750		3,188	1,805
Washington							
West Virginia	160	40				775	200
Wisconsin	70,285	13,278	37,936	26,507	11,156	54,033	51,794
Wyoming	843	300				1,200	
Total	2,276,574	2,995,450	464,837	165,781	36,807	820,002	1,348,172

Value of the production of limestone in the United States in 1910 and 1911, by States and uses—Continued.

1910—Continued.

State.	Crushed stone.			Flux.	Sugar factories.	Other.	Total.
	Road making.	Railroad ballast.	Concrete.				
Alabama	$64,872	$5,842	$16,199	$545,988		$3,708	$714,516
Arizona							(a)
Arkansas	3,600	24,500	4,500			950	84,280
California	314,786		5,550	136,132	$116,091	17,360	590,990
Colorado		1,640		328,549	83,767	1,567	415,523
Connecticut	206			2,391		4,851	[b] 9,062
Florida	30,250	1,400	19,500			3,629	[c] 84,457
Georgia	326	3,406	1,509	17,630			24,236
Idaho	1,000				18,423		19,423
Illinois	954,409	520,132	953,502	854,615	21,004	68,214	3,847,715
Indiana	551,021	125,498	133,186	203,718	965	83,604	4,472,241
Iowa	57,168	35,434	255,233	625		5,240	543,600
Kansas	72,965	271,023	166,996	142		3,019	768,739
Kentucky	288,611	317,221	110,602	9,627		13,649	978,809
Louisiana							(d)
Maine							(e)
Maryland	96,453	6,662	39,537	4,334		734	154,370
Massachusetts							(e)
Michigan	110,184	42,358	178,318	100,149	69,647	299,305	842,126
Minnesota	31,665	750	253,082	378	2,812	145	654,833
Missouri	509,559	204,988	479,394	51,775	8,822	41,785	2,360,604
Montana	150			151,576		9,433	169,836
Nebraska	10,000		229,164		1,651	19	338,731
New Jersey	16,191		6,615	199,532		94	224,707
New Mexico	7,225	201,153	9,367	6,664	1,648		[f] 227,657
New York	985,240	545,615	341,979	469,193		246,411	2,813,476
North Carolina							(g)
Ohio	1,300,348	789,130	330,190	1,263,605	6,057	148,129	4,357,432
Oklahoma	20,908	162,932	156,784			1,904	509,344
Oregon	800		200	594			3,594
Pennsylvania	409,643	495,002	455,301	3,735,060		121,137	5,394,611
Rhode Island							(e)
South Carolina							(g)
South Dakota	9,200		5,750				17,150
Tennessee	298,330	123,530	102,788	100,865		8,242	[h] 747,162
Texas	92,514	24,244	140,454	39,006		2,150	447,239
Utah			5,100	186,466	12,656	813	389,603
Vermont	10,840		3,750	345		4,045	25,250
Virginia	20,056	108,129	36,849	294,668		6,288	471,903
Washington	1,077			28,145	480	6,484	36,186
West Virginia	3,449	229,462	20,400	574,693		11,885	841,064
Wisconsin	322,671	48,380	297,051	39,268		7,163	979,522
Wyoming			22,364		18,377	603	43,687
Total	6,595,717	4,288,431	4,781,214	9,345,733	362,400	1,122,560	34,603,678

[a] Included in New Mexico.
[b] Includes Maine, Massachusetts, and Rhode Island.
[c] Includes Louisiana.
[d] Included in Florida.
[e] Included in Connecticut.
[f] Includes Arizona.
[g] Included in Tennessee.
[h] Includes North Carolina and South Carolina.

Value of the production of limestone in the United States in 1910 and 1911, by States and uses—Continued.

1911.

State.	Rough building.	Dressed building.	Paving.	Curbing.	Flagging.	Rubble.	Riprap.
Alabama	$2,115	$29,652	$170	$150			$10,459
Arizona	800						1,400
Arkansas	22,300	24,445					19,981
California	283		40				
Colorado							552
Connecticut							
Florida		2,000					
Georgia	1,404						
Idaho		535				$20	40
Illinois	34,252	16,775	81,935	5,071	$2,979	191,848	28,275
Indiana	1,082,154	1,972,903	965	76,039	5,207	19,369	12,108
Iowa	35,048	4,302	37,924	3,250	1,017	29,061	89,410
Kansas	61,147	30,991	47,754	4,202	250	20,167	35,515
Kentucky	98,234	77,819	582	13,825	760	1,845	46,418
Louisiana							
Maine							
Maryland	9,848		73	45	75		160
Massachusetts							
Michigan	7,526					165	380
Minnesota	74,531	130,637	9,650	4,600	3,493	29,035	72,718
Missouri	132,011	380,282	70,074	3,388	4,559	247,263	247,210
Montana	5,285						
Nebraska	2,763		16,929	4,000	500	1,645	24,536
Nevada							
New Jersey	341						
New Mexico							
New York	110,919	25,086	6,278	5,053	167	15,523	32,517
North Carolina							
Ohio	73,272	4,846	4,000	2,200		40,724	623,965
Oklahoma	15,590	1,500	53,492			3,750	48,735
Oregon							
Pennsylvania	89,798	4,545	120,835	5,960	1,200	6,595	4,201
Rhode Island							
South Carolina							
South Dakota						200	800
Tennessee	3,879	5,130	2,500	1,131		2,669	88,428
Texas	31,162	22	14,850	1,833	750	4,205	51,421
Utah	24,702	750	25			260	19,166
Vermont	1,610					2,500	
Virginia	701		226				
Washington							
West Virginia	4,320	40	1,536			2,500	650
Wisconsin	71,662	11,783	12,430	23,146	6,452	20,689	102,173
Wyoming	100					275	55
Total	1,997,757	2,724,043	482,268	153,893	27,409	640,308	1,561,273

Value of the production of limestone in the United States in 1910 and 1911, by States and uses—Continued.

1911—Continued.

State.	Crushed stone.			Flux.	Sugar factories.	Other.	Total.
	Road making.	Railroad ballast.	Concrete.				
Alabama	$37,511		$23,077	$458,356		$308	$561,798
Arizona				683	$3,793	2,000	8,676
Arkansas		$7,615	61,666				[a] 136,007
California	192,572	10,913	170,552	93,272	92,594	16,475	576,701
Colorado	250			284,142	54,219	2,635	341,798
Connecticut	323		1,110	7,166		12,441	[b] 21,040
Florida	72,500	16,945	3,000			3,075	97,520
Georgia		6,000	4,926	5,855		13,447	31,632
Idaho				49	17,853	1,000	[c] 19,497
Illinois	750,583.	453,465	1,038,882	728,544	3,606	100,762	3,436,977
Indiana	783,328	118,486	103,858	165,250		66,910	4,406,577
Iowa	39,496	162,704	267,936	660	7,110	1,977	679,895
Kansas	142,895	275,373	164,518			6,636	789,448
Kentucky	374,010	349,714	138,462	6,243		16,258	1,124,170
Louisiana							(d)
Maine							(e)
Maryland	101,697	48,397	47,230	5,759		5,352	218,636
Massachusetts							(e)
Michigan	113,574	34,998	137,285	186,046	65,141	456,420	1,001,535
Minnesota	63,406	27,020	175,761	570	3,000	18,494	612,915
Missouri	399,869	176,101	435,679	24,593	11,861	46,877	2,179,767
Montana	10,265	245	751	120,401	11,179		148,126
Nebraska	9,610	1,950	200,318		1,108	100	263,459
Nevada							(f)
New Jersey	11,616	10,269	10,340	91,781		13,801	138,148
New Mexico		229,469	13,650				243,119
New York	856,279	679,861	463,758	443,522		218,834	2,857,797
North Carolina	15,578			5,000		9,700	30,278
Ohio	1,505,154	520,645	398,224	1,089,236	9,051	190,565	4,461,882
Oklahoma	16,850	305,550	146,637			2,560	594,664
Oregon							(f)
Pennsylvania	560,212	390,938	510,297	3,396,304		152,160	5,243,045
Rhode Island							(e)
South Carolina							(g)
South Dakota	250		5,000				6,250
Tennessee	406,448	90,444	80,904	109,633		7,203	[h] 798,369
Texas	91,171	175,386	114,075	467		4,947	490,289
Utah	1,680		5	114,307	6,250	1,000	168,145
Vermont	7,775		3,450	736		3,631	19,702
Virginia	42,643	126,884	40,677	143,099		15,642	369,872
Washington				26,179		6,299	32,478
West Virginia	9,365	356,457	49,962	422,902		54,345	902,077
Wisconsin	269,945	44,143	211,157	56,453		18,330	848,363
Wyoming			18,383		13,952	4,195	36,960
Total	6,886,855	4,619,972	5,041,530	7,987,208	300,717	1,474,379	33,897,612

[a] Includes Louisiana.
[b] Includes Maine, Massachusetts, and Rhode Island.
[c] Includes Nevada and Oregon.
[d] Included with Arkansas.
[e] Included with Connecticut.
[f] Included with Idaho.
[g] Included with Tennessee.
[h] Includes South Carolina.

Building stone.—Limestone for buliding purposes, including rough and dressed stone, sold by producers decreased in value $550,224, from $5,272,024 in 1910 to $4,721,800 in 1911. The decrease was both in the dressed limestone, which declined from $2,995,450 in 1910 to $2,724,043 in 1911, and in the rough stock, which decreased from $2,276,574 in 1910 to $1,997,757 in 1911.

The output of building stone in Indiana was valued at $3,055,057 in 1911, which was a little more than 64 per cent of the total for the United States, and therefore more than the proportion produced in 1910, which was about 62 per cent. The decrease in value for Indiana in 1911 was $215,647. The output of limestone in Indiana is quarried principally in Lawrence and Monroe counties, and is well known as Bedford oolitic limestone, from the town of Bedford, Lawrence County, which, with Bloomington, Monroe County, forms the shipping center for this stone. This Bedford stone is chiefly used for building stone, although some is sold for flagstone, curbstone, monumental stone, crushed stone, furnace flux, and some—not included in this report—is used for lime and for cement. Exclusive of 53,242 short tons of stone valued at $27,842, used for riprap, crushed stone, furnace flux, etc., the total quantity and value of limestone produced in Lawrence County in 1911 were 6,612,988 cubic feet, valued at $2,171,148; Monroe County produced, exclusive of 50,914 short tons, valued at $45,112, for flux, etc., 2,915,444 cubic feet of other stone, valued at $859,580. The total for the two counties, exclusive of the flux, etc., was therefore 9,528,442 cubic feet, valued at $3,030,728. In 1910 the total output of building stone from these two counties was 9,738,808 cubic feet, valued at $3,106,520, a decline in 1911 of 210,366 cubic feet in quantity and of $75,792 in value. In 1910 the quantity of stone sold for other than building purposes from these two counties, not included in the figures above, was 202,245 short tons, valued at $120,130, a decrease in 1911 in this class of material of 98,089 short tons in quantity and of $47,176 in value. The low price per ton was due to the low price obtained for waste stone sold for flux. In 1910 the total quantity for the two counties inclued 5,650,811 cubic feet of stone sold rough, of which 3,627,512 cubic feet, valued at $814,021, were from Lawrence County, and 2,023,299 cubic feet, valued at $342,598, were from Monroe County. In 1911 there were 5,389,513 cubic feet of rough stone sold, a decrease from 1910 of 261,298 cubic feet of rough stock. In 1910 the two counties reported 4,087,997 cubic feet of dressed stone, of which 2,151,148 cubic feet, valued at $1,027,212, were from Lawrence County, and 1,936,849 cubic feet, valued at $922,689, from Monroe County. In 1911 the quantity of dressed stone sold was 4,138,929 cubic feet, an increase of 50,932 cubic feet over 1910. In 1911 the total value of dressed stone from Lawrence County was $1,341,283, and from Monroe County, $603,739, an increase in 1911 of $314,071 for Lawrence County and a decline of $318,950 for Monroe County. Most of this stone was for building, but there was included a small quantity for rubble, curbstone, and flagstone. The average price per cubic foot for rough stone in 1911 was 20 cents, the same as in 1910; for dressed stone in 1910 it was 48 cents, and in 1911, 47 cents.

The following table shows the production of Bedford oolitic limestone in Lawrence and Monroe counties, Ind., from 1901 to 1911, inclusive. This limestone was sold as rough and dressed building stone and for rubble, riprap, curbing, flagging, and flux, and also as crushed stone for road making, ballast, concrete, etc.

Production of Bedford oolitic limestone in Lawrence and Monroe counties, Ind., 1901–1911.

Year.	Lawrence County.		Monroe County.		Total.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
1901		$1,365,875		$421,599		$1,787,474
1902		1,207,497		439,902		1,637,399
1903		1,088,477		487,662		1,576,139
1904		1,054,302		589,672		1,643,974
1905		1,550,076		843,399		2,393,475
1906		1,460,743		1,162,062	[a]9,282,004	2,622,805
1907		1,413,280		908,612	[a]7,849,027	2,321,892
					[b]256,960	110,525
1908	[a]5,199,996	1,498,822	[a]3,147,097	880,218	[a]8,347,093	2,379,040
	[b]93,085	42,150	[b]8,260	1,719	[b]101,705	43,869
1909	[a]6,441,483	1,678,195	[a]2,970,388	801,436	[a]9,411,871	2,479,631
	[b]145,672	71,637	[b]106,600	56,925	[b]252,272	128,562
1910	[a]5,778,660	1,841,233	[a]3,960,148	1,265,287	[a]9,738,808	3,106,520
	[b]131,590	75,906	[b]70,655	44,224	[b]202,245	120,130
1911	[a]6,612,988	2,171,148	[a]2,915,444	859,580	[a]9,528,442	3,030,728
	[b]53,242	27,842	[b]50,914	45,112	[b]104,156	72,954

[a] Cubic feet.

[b] Short tons.

The following table shows the production of Bedford oolitic limestone in Lawrence and Monroe counties, Ind., in 1910 and 1911, by uses:

Production of Bedford oolitic limestone in Lawrence and Monroe counties, Ind., in 1910 and 1911, by uses.

1910.

County.	Building.						Other uses.[a]		Total value.
	Rough.		Dressed.		Total.				
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	
Lawrence	3,627,512	$814,021	2,151,148	$1,027,212	5,778,660	$1,841,233	131,590	$75,906	$1,917,139
Monroe	2,023,299	342,598	1,936,849	922,689	3,960,148	1,265,287	70,655	44,224	1,309,511
Total	5,650,811	1,156,619	4,087,997	1,949,901	9,738,808	3,106,520	202,245	120,130	3,226,650
Average price		$0.20		$0.48		$0.32		$0.59	

1911.

County.	Rough Quantity.	Rough Value.	Dressed Quantity.	Dressed Value.	Total Quantity.	Total Value.	Other uses Quantity.	Other uses Value.	Total value.
Lawrence	3,786,538	$829,865	2,826,460	$1,341,283	6,612,998	$2,171,148	53,242	$27,842	$2,198,990
Monroe	1,602,975	255,841	1,312,469	603,739	2,915,444	859,580	50,914	45,112	904,692
Total	5,389,513	1,085,706	4,138,929	1,945,022	9,528,442	3,030,728	104,156	72,954	3,103,682
Average price		$0.20		$0.47		$0.32		$0.70	

[a] Used for crushed stone, flux, curbing, flagging, etc.

Missouri ranked next to Indiana in output of building limestone, the value of the output in 1910 being $573,361, as against $512,293 for 1911, a decrease in 1911 of $61,068. This stone, a strong light-gray crystalline limestone, is principally from Carthage, Jasper County. The value of the limestone produced in the Carthage district in 1911 was $324,789, as compared with $382,756 in 1910, a decrease of $57,967. The output in 1911 consisted of 427,974 cubic feet of building stone, valued at $293,470, an average of 68.6 cents per cubic foot; of curbing, valued at $2,427; of flagging, valued at $2,431; of rubble, valued at $2,596; and of stone for miscellaneous uses, valued at $23,865. All of these items except curbing and stone for uses not specified, show a decrease in 1911.

The following table shows the production of limestone near Carthage, Jasper County, Mo., in 1908–1911, by uses:

Production of limestone at Carthage, Jasper County, Mo., in 1908–1911, by uses.

Year.	Number of producers.	Building stone.		Curbing.	Flagging.	Rubble.	Other.[a]	Total value.
		Quantity.	Value.	Value.	Value.	Value.	Value.	
		Cubic feet.						
1908	8	431,576	$280,249	$5,238	$3,602	$2,682	$17,826	$309,597
1909	8	481,274	334,715	1,263	6,232	3,791	24,001	370,002
1910	10	502,161	347,244	1,767	7,229	2,945	23,571	382,756
1911	9	427,974	293,470	2,427	2,431	2,596	23,865	324,789

[a] Includes stone used for monumental work, crushed stone, stone sold to glass factories, blast furnaces, sugar factories, etc.

Another limestone of increasing importance to the building trade in the Central States is the oolitic limestone quarried near Bowling Green, Ky. The production of this district was published separately for the first time in the report for 1910. From 1909 to 1910 there was a slight increase in quantity, but a decrease in value of about 7 per cent. From 1910 to 1911 there was a still further decrease in total value, representing more than 10 per cent of the 1910 value. The following table shows the quantity and value of this limestone produced in 1909, 1910, and 1911:

Production of limestone in Warren County, Ky., by uses, 1909–1911.

	Rough building.		Dressed building.		Crushed stone.		Other.[a]	Total value.
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Value.	
	Cubic feet.		*Cubic feet.*		*Short tons.*			
1909	203,120	$60,936	74,482	$62,989	46,725	$22,013	$33,704	$179,642
1910	204,602	56,141	90,100	57,350	108,183	47,532	5,584	166,607
1911	134,291	45,792	103,220	76,589	57,720	25,921	250	148,552

[a] Curbing, flagging, fluxing, and monumental stone.

Paving.—Limestone for paving increased in value from $464,837 in 1910 to $482,268 in 1911, or $17,431. Pennsylvania, Illinois, Missouri, Oklahoma, Kansas, and Iowa produced most of the limestone used for paving in 1911.

Curbing.—There was a decrease of $11,762 in the value of the curbstone output, from $165,781 in 1910 to $153,893 in 1911. Indiana, Wisconsin, and Kentucky furnished most of this material in 1911.

Flagging.—A decrease of $9,398 marked the limestone output of flagging in 1911, from $36,807 in 1910 to $27,409 in 1911. Most of this stone was from Wisconsin, Indiana, Missouri, and Minnesota.

Rubble.—Rubble decreased in value $180,594, from $820,002 in 1910 to $639,408 in 1911. Missouri, Illinois, and Ohio reported the largest production.

Riprap.—Riprap increased in value $213,101, from $1,348,172 in 1910 to $1,561,273 in 1911. Ohio, Missouri, and Wisconsin produced most of this stone in 1911.

Crushed stone.—Crushed limestone used in road making, railroad ballast, concrete, etc., had a larger value than any other limestone product. In 1911 this output was 30,448,441 short tons, valued at $16,548,357, an increase of 784,461 short tons in quantity and of $882,995 in value for 1911 as compared with 1910, when the figures were 29,663,980 short tons, valued at $15,665,362.

In 1911 the total output was divided into 12,075,515 short tons, valued at $6,886,855, for road making; 9,708,418 short tons, valued at $4,619,972, for railroad ballast; and 8,664,508 short tons, valued at $5,041,530, for concrete, which, compared with the itemized output for 1910—road making, 11,947,794 tons, valued at $6,595,717; railroad ballast, 9,340,573 tons, valued at $4,288,431; concrete, 8,375,613 tons, valued at $4,781,214—was an increase of 127,721 tons in quantity and of $291,138 in value for road making, an increase of 367,845 tons in quantity and of $331,541 in value for railroad ballast, and an increase of 288,895 tons in quantity and of $260,316 in value for concrete. It is possible that the stone for road making includes some stone used for concrete, some of the operators reporting that they were unable to subdivide, except approximately, their total output of crushed stone, not knowing the exact use which was to be made of the stone. The average price per short ton was 54 cents in 1911, compared with 53 cents in 1910.

Ohio ranked first in 1911 in the production of crushed limestone and Illinois ranked second.

Furnace flux.—Next to crushed stone, limestone sold for furnace flux showed the largest value. The production in 1911 was 16,126,650 long tons, valued at $7,987,208; in 1910 it was 18,203,882 long tons, valued at $9,345,733, a decrease in 1911 of 2,077,232 tons in quantity and of $1,358,525 in value. The average price per ton was 51 cents in 1910 and 50 cents in 1911. Pennsylvania, Ohio, Illinois, West Virginia, Alabama, New York, and Colorado were the principal producers.

The following table shows the production of limestone for smelter, open-hearth, and blast-furnace flux in 1910 and 1911, by States, in long tons:

Production of furnace flux, etc., in 1910 and 1911, by States, in long tons.

State.	1910		1911	
	Quantity.	Value.	Quantity.	Value.
Alabama	1,022,381	$545,988	831,864	$458,356
Arizona	(a)	(a)	692	683
California	123,421	136,132	84,247	93,272
Colorado	531,903	328,549	518,643	284,142
Connecticut	(a)	(a)	[b] 5,364	[b] 7,166
Georgia	24,949	17,630	9,838	5,855
Illinois	2,166,372	854,615	1,927,785	728,544
Indiana	367,441	203,718	334,471	165,250
Iowa	971	625	1,071	660
Kansas	420	142		
Kentucky	16,846	9,627	11,088	6,243
Maryland	6,909	4,334	10,284	5,759
Massachusetts			(c)	(c)
Michigan	223,830	100,149	341,027	186,046
Minnesota	562	378	842	570
Missouri	71,310	51,775	27,618	24,593
Montana	276,642	151,576	228,147	120,401
New Jersey	374,993	199,532	183,267	91,781
New York	789,740	469,193	781,247	443,522
North Carolina			10,000	5,000
Ohio	2,421,427	1,263,605	2,335,048	1,089,236
Oregon	412	594	84	49
Pennsylvania	7,545,094	3,735,060	6,769,949	3,396,304
Rhode Island	(a)	(a)	(a)	(c)
South Carolina	(a)	(a)	(d)	(d)
Tennessee	182,561	100,458	[e] 198,050	[e] 109,633
Texas	56,171	39,006	504	467
Utah	270,105	186,466	194,659	114,307
Vermont	345	345	536	736
Virginia	540,324	294,668	281,968	143,099
Washington	28,710	28,145	28,396	26,179
West Virginia	1,072,193	574,693	886,268	422,902
Wisconsin	74,268	39,268	123,693	56,453
Other States	[f] 13,582	[f] 9,462		
Total	18,203,882	9,345,733	16,126,650	7,987,208
Average price per ton		.51		.50

[a] Included in other States.
[b] Includes Massachusetts and Rhode Island.
[c] Included with Connecticut.
[d] Included in Tennessee.
[e] Includes South Carolina.
[f] Includes Arizona, Connecticut, Rhode Island, and South Carolina.

Other uses.—Stone for other uses includes stone quarried and used by sugar refiners in several States and by alkali works in New York and Michigan; stone sold to glass factories, to paper mills, and to carbonic-acid plants; stone for making whiting and mineral wool; and also a small quantity sold to farmers for burning into lime to be used as a fertilizer, it being impossible to get the lime value for this stone. Stone reported as sold to sugar refiners decreased in value from $362,400 in 1910 to $300,717 in 1911, a decline of $61,683. There were reported, and included under "Other uses," 174,290 short tons of ground limestone used chiefly for fertilizing the ground. The total output of stone for these various uses increased in value $351,819, from $1,122,560 in 1910 to $1,474,379 in 1911.

MARBLE.

Total value.—The figures for marble production here presented include, for some of the States, the value of serpentine (verde antique marble) and "onyx" marble. The serpentine included is that form which, from its use as ornamental stone for interior decorative work in buildings, answers the purpose of marble. The Georgia and Pennsylvania figures in this report include this stone. Onyx marble, or cave onyx, is included in the production of Kentucky and New Mexico.

In 1911 the commercial output of marble came from Vermont, Georgia, Colorado, Tennessee, New York, Alabama, Massachusetts, Pennsylvania, California, Alaska, Oklahoma, Maryland, Arizona, North Carolina, Kentucky, New Mexico, South Carolina, Utah, and Oregon, named in order of value of output.

The marble output in the United States was valued in 1910 at $6,992,779, and in 1911 at $7,546,718, a gain of $553,939.

The chief uses of marble are as building stone, for exterior and interior work, and for monuments.

The following table shows the value of the marble produced in the United States from 1907 to 1911, by States:

Value of marble produced in the United States, 1907–1911, by States and Territories.

State or Territory.	1907	1908	1909	1910	1911
Alabama	$85,475	[a] $118,580	[b] $212,462	[c] $255,664	[d] $335,005
Alaska	38,110	[e] 103,888	[f] 46,900	(g)	(h)
Arizona	....	....	(i)	....	(h)
California	183,285	60,408	89,392	[j] 112,339	29,964
Colorado	....	(k)	488,311	[l] 488,173	[m] 1,010,840
Georgia	864,757	916,281	766,449	953,917	1,088,422
Idaho	(i)	....	....	....	....
Kentucky	12,500	(n)	(n)	(n)	(n)
Maryland	98,918	[o] 79,317	(n)	(p)	[q] 73,300
Massachusetts	212,438	175,648	243,711	224,088	219,445
Missouri	(r)	(n)	....	....	....
New Mexico	[s] 7,535	(k)	[t] 5,390	(h)	(h)
New York	911,951	706,858	402,729	484,732	379,670
North Carolina	....	(u)	(n)	(n)	(u)
Oklahoma	16,805	....	....	....	(n)
Oregon	....	....	(h)	....	....
Pennsylvania	118,539	102,747	186,037	[v] 182,514	214,913
South Carolina	....	....	....	....	(u)
Tennessee	688,148	790,233	613,741	728,502	700,229
Texas	....	....	(i)	(h)	....
Utah	2,500	(k)	(h)	(h)	(k)
Vermont	4,596,724	4,679,960	3,493,783	3,562,850	3,394,930
Washington	(i)	....	(k)	(g)	....
West Virginia	....	....	(n)	(n)	....
Total	7,837,685	7,733,920	6,548,905	6,992,779	7,546,718

[a] Includes Kentucky and Missouri.
[b] Includes Kentucky, Maryland, North Carolina, and West Virginia.
[c] Includes Kentucky, North Carolina, and West Virginia.
[d] Includes Kentucky and Oklahoma.
[e] Includes Colorado, New Mexico, and Utah.
[f] Includes Washington.
[g] Included in California.
[h] Included in Colorado.
[i] Included in New Mexico.
[j] Includes Alaska and Washington.
[k] Included in Alaska.
[l] Includes Arizona, New Mexico, and Utah.
[m] Includes Alaska, Arizona, New Mexico, Oregon, and Utah.
[n] Included in Alabama.
[o] Includes North Carolina.
[p] Included in Pennsylvania.
[q] Includes North Carolina and South Carolina.
[r] Included in limestone.
[s] Includes Idaho and Washington.
[t] Includes Arizona and Texas.
[u] Included in Maryland.
[v] Includes Maryland.

The following table shows the various uses to which the marble quarried in 1906, 1907, 1908, 1909, 1910, and 1911 was put:

Distribution and value of the output of marble, 1906–1911, among various uses.

Use.	1906	1907	1908	1909	1910	1911
Sold by producers in rough state	$1,795,169	$1,697,891	$1,455,980	$2,330,336	$2,098,480	$3,182,620
Dressed for—						
Building	1,559,925	1,905,145	2,329,438	1,293,019	1,463,749	1,220,635
Ornamental purposes	44,523	25,050	25,506	24,695	37,950	71,000
Monumental work	2,214,872	2,044,000	1,843,426	1,184,672	1,279,985	1,368,430
Interior decoration in buildings	1,722,445	1,900,952	1,943,750	1,557,783	2,001,646	1,545,963
Other uses	246,004	264,647	135,820	158,400	110,969	158,070
Total	7,582,938	7,837,685	7,733,920	6,548,505	6,992,729	7,546,718

Building stone.—The value of building marble, rough and dressed, as sold by the producer, was $2,910,267 in 1911, an increase of $552,472 over the value for 1910, which was $2,357,795. The total for 1911 included $1,689,632 reported for rough and $1,220,635 for dressed building stone; in 1910 the rough building marble sold was valued at $894,046 and the dressed building stone at $1,463,749, an increase in 1911 of $795,586 for rough stock and a decrease of $243,114 for dressed marble.

Monumental stone.—Monumental marble was valued at $2,170,981 in 1910 and at $2,621,213 in 1911, an increase of $450,232 in 1911. In 1910 the value of rough stock was $890,996 and of dressed monumental stone, $1,252,783; the corresponding figures for 1911 are $1,279,985 for rough monumental stock, and $1,368,430 for dressed monumental stone, an increase in 1911 of $361,787 in value of rough stock and of $88,445 for dressed stone.

Interior work.—Vermont, Tennessee, Alabama, Colorado, and Massachusetts produced most of the marble used for interior decorations, the total value for 1911 being $1,545,963, as against $2,001,646 in 1910, a loss in 1911 of $455,683.

Other marble.—Rough stone for other uses includes waste marble sold to lime burners, to carbonic-acid factories, to pulp mills, to iron furnaces for flux, and that used for road making, etc.; the dressed stone includes stone for mosaics, electrical work, etc.

As the requests to the producers for the report of their marble output in 1911 were in a form different from that used in preceding years, it is impossible to compare the uses of the marble as sold in the different States according to uses, and that table is therefore omitted from this report. The following statement of the marble output of the United States shows the quantity and value of this material and the form in which it was sold by the producer:

Total quantity and value of marble produced in the United States in 1911, according to form in which it was sold.

Form in which sold by producer.		Quantity.	Value.
In rough blocks:			
To manufacturers	short tons	1,384	$3,600
	cubic feet	1,351,137	2,129,708
To dealers	cubic feet	33,450	48,313
Direct for—			
Monumental work	cubic feet	376,925	542,877
Buildings	short tons	35,475	26,997
	cubic feet	4,650	3,689
Rough sawed:			
To manufacturers	cubic feet	361,546	567,584
	square feet	93,596	29,798
To dealers	cubic feet	25,500	51,275
Direct for—			
Monumental work	cubic feet	55,095	86,264
Buildings	cubic feet	16,752	17,163
Finished:			
To manufacturers	short tons	720	96,000
	cubic feet	404,636	1,653,309
	square feet	2,000	1,000
To dealers	cubic feet	81,549	306,820
Direct for—			
Monumental work	short tons	25	962
	cubic feet	31,247	75,308
	square feet	3,000	4,500
Ornamental purposes	cubic feet	27,000	70,000
	square feet	2,000	1,000
Interior decoration	short tons	600	40,000
	cubic feet	435,138	1,502,610
	square feet	4,353	3,353
As crushed stone	short tons	39,686	56,762
As ground limestone	short tons	3,866	14,637
Other purposes	short tons	67,958	53,189
	cubic feet	1,510,000	160,000
Total	short tons	149,714	292,147
	cubic feet	4,714,625	7,214,920
	square feet	104,949	39,651
			7,546,718

The following table shows the quantity and value of the marble sold by the producers in the most prominent marble States:

Quantity and value of marble produced in California, Georgia, Massachusetts, New York, Pennsylvania, Tennessee, and Vermont in 1911.

State.	Quantity.	Value.
California:		
Short tons	2,202	$102,964
Square feet	79,000	27,000
Total		129,964
Georgia:		
Short tons	10,979	26,547
Cubic feet	935,950	1,061,875
Total		1,088,422
Massachusetts:		
Short tons	8,688	21,071
Cubic feet	103,086	194,223
Square feet	5,949	4,151
Total		219,445
New York:		
Short tons	66,736	54,178
Cubic feet	149,756	250,492
Cubic yards	50,000	75,000
Total		379,670
Pennsylvania:		
Short tons	46,443	138,916
Cubic feet	54,075	75,997
Total		214,913
Tennessee:		
Cubic feet	414,128	700,229
Vermont:		
Short tons	5,100	5,100
Cubic feet	1,186,015	3, 85,830
Square feet	17,000	4,000
Total		3,394,930

STONE RESOURCES EAST OF MISSISSIPPI RIVER.

GENERAL STATEMENT.

Within the last few years the United States Geological Survey has received many requests for maps showing areas of stone suitable for building and other purposes in the United States. Such a set of maps is doubtless very desirable, and their preparation may be considered a goal to be attained at some future time, but not under present conditions, as the preparation of such a publication would entail an expense not compatible with the funds at present available. The compilation of a reconnaissance geologic map of the United States has occupied the time of a geologist for many years. This geologic map shows, for the most part, the rocks subdivided on the basis of age—not on a lithologic basis—and therefore, in order to make it a serviceable stone map, it would be necessary to resubdivide and reclassify all the cartographic units on the basis of the character of the rock, which would require years of additional field and office work. This reconnaissance geologic map of the United States is now available; it is contained in the geologic map of North America, issued in 1911 by the Survey, and is for sale at 75 cents a copy. This map shows on a scale of approximately 80 miles to 1 inch the main subdivisions of rocks by geologic systems, and in some places by series, but it does not show the rock formations, such as limestones, sandstones, granites, etc., that are suitable and available for quarry products. The Survey has been issuing, from time to time, special reports on certain types of stone within limited areas, as, for instance, on granite in certain States, on marble or limestone, or structural materials in general, in certain districts, and occasionally a note on stones suitable for building purposes is included in a geologic folio text; but, taken altogether, the work done on this subject is hardly more than begun. In most of the States, especially those east of Mississippi River, the locations of the stone quarries already opened outline in a general way the areas underlain by suitable stone, although, of course, suitable stone may extend far beyond the areas actually developed. Markets and transportation are the two factors that exert the greatest influence on the development of stone, even though the stone may be admittedly of an excellent quality, and may be in a convenient position for quarrying. With all these limitations in mind, it was decided that the most practicable maps bearing on the stone industry that could be prepared by the Survey in the short time available for the work should indicate the locations of quarries by classes of stone. Accordingly a set of maps showing quarries throughout the United States by classes of stone is in preparation, and maps comprising the States east of Mississippi River are issued as an accompaniment of this chapter of Mineral Resources. If these stone-quarry maps are studied in connection with the geologic map of the United States mentioned above, many interesting economic and scientific relations between the stone industry and areal geology may be observed.

A few notes in general explanation of the maps should be included here. It was the aim in the preparation of these maps to present an outline of quarry areas in so far as practicable without special reference to the output of stone from any given area. For instance, if there are so many quarries at or near one place that it is impracticable to represent each quarry by a separate symbol, one or two symbols only are given; on the other hand, in an isolated place there may be but one quarry and that a small one, yet the fact that quarriable stone occurs at that place has been regarded as the important point to be brought out by these maps, and the isolated quarry is therefore indicated by the appropriate symbol. Naturally, where the quarry industry predominates in a county or a district, these maps readily indicate that fact, as inspection of Plates II and VI shows at a glance that there are many granite quarries near Portland, Me., many limestone quarries in the vicinity of Bedford, Ind., and many sandstone quarries near Cleveland, Ohio; but equally interesting and possibly of even more importance to the question of distribution of stone resources is the demonstration that there is also quarriable granite in Aroostook County, Me., limestone in Rensselaer County, Ind., and sandstone in Highland County, Ohio. A provision has been made in the directories accompanying the maps which shows the number of quarries represented by a single symbol.

For instance, with regard to granite symbol numbered 23 on Plate II, the directory gives "23—Stonington (14)"—indicating that 14 granite quarries are represented by the single granite symbol at Stonington. The limestone quarrying industry and the manufacture of lime are so intimately associated, practically every lime manufacturer at times selling some crushed stone or other form of stone not burned and many stone producers making lime as an adjunct to their stone business, that the locations of lime kilns have also been given on these maps, by simply modifying the triangular limestone symbol into a double triangle which indicates "limestone and lime." On the other hand, limestone quarries operated as a source of material for the manufacture of cement have not been included, because as a rule they are operated solely for cement material, the sale of stone from them being negligible. Besides this, the location of cement plants has been shown on maps accompanying the chapters on the cement industry in Mineral Resources for both 1910 and 1911.

The advisability of giving a tabulation of such chemical analyses of stones as are available has been considered, but since analyses of stones other than limestones are of rather doubtful value this matter has been disposed of by giving in the Mineral Resources chapter on the production of lime in 1911 an extensive tabulation of chemical analyses of both limestone and limes, from all parts of the country, including both high calcium and high magnesian materials.

Under marbles no distinction has been made in the quarry symbols between true metamorphic marbles and crystalline limestones susceptible of a high polish, since the latter class includes some very valuable marbles of commerce.

The preparation of this map was begun in 1911, using as a basis the Survey's list of stone producers in 1910. Before going to press some revision was made in order to bring the list up to date, but it probably has been unavoidable to include some quarries now inactive, and probably it has been impossible to include every place in which stone is quarried. However, the first fault is not a disadvantage, because, although a quarry may have been abandoned temporarily, it by no means follows that the quarriable stone has been exhausted, and the symbol stands not wholly to show the location of a quarry but the existence of a certain type of stone at that place.

There are certain limitations to the accuracy of these maps which should be mentioned here. The scale of the maps is approximately 40 miles to 1 inch. On this scale the quarry symbols, which have been made as small as is compatible with convenient reading and interpolation, are still so large that each one covers much more area than an average sized quarry. Where quarries are close together it has therefore been necessary to place the symbol as near the determined locality as possible, without running the symbols together or superimposing one upon another. In the great majority of counties the only town shown on the base map is the county seat. Therefore the location of all other places where quarries are situated has been of necessity interpolated from other Government maps, commercial atlases, and railroad maps. Not all these maps are agreed in all details, and many of the locations resulting from comparisons of these various sources of information are to some extent compromises. One other unavoidable source of error is that the exact location of a quarry may not have been given by the stone producer in his reports

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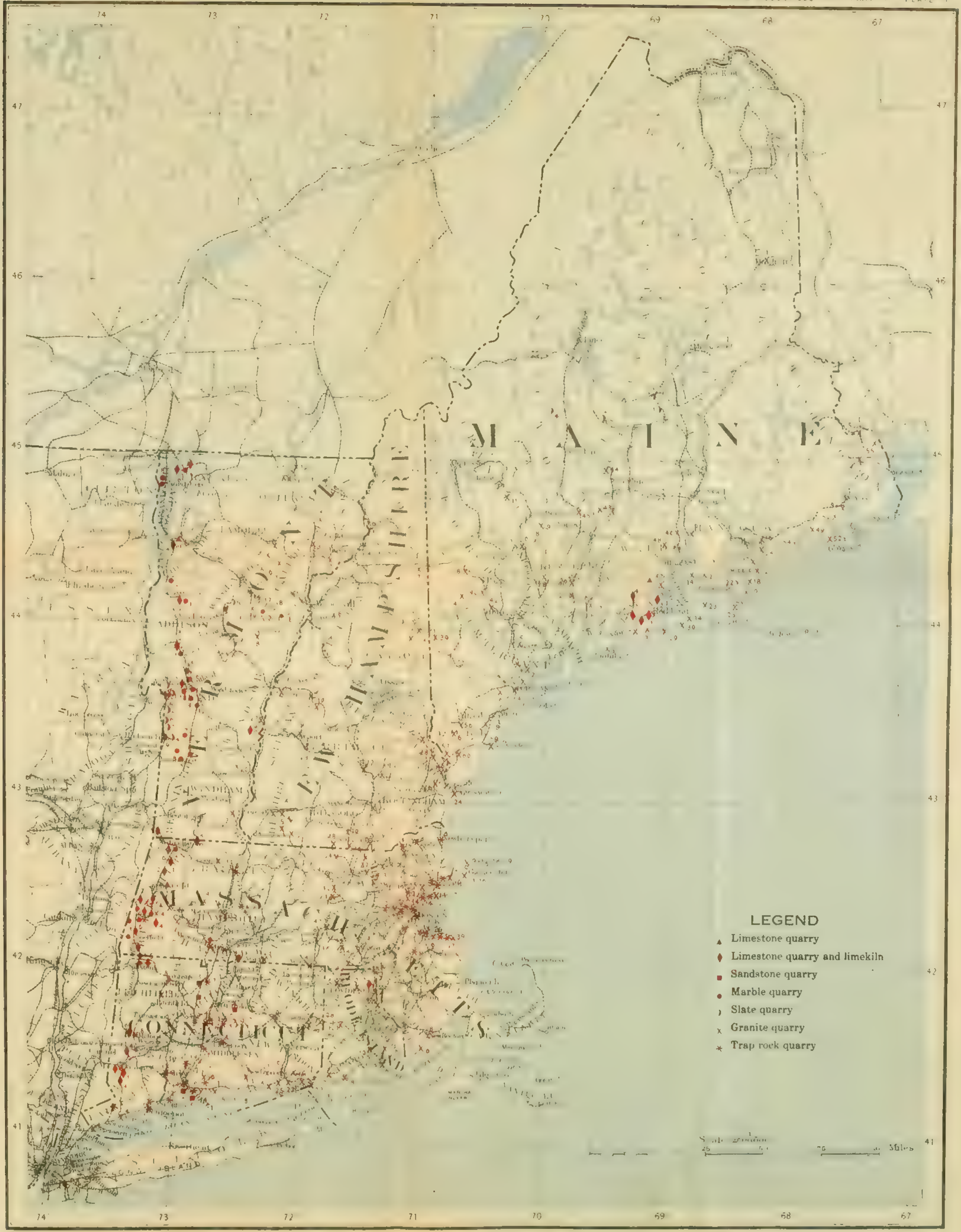
E. F. Burchard

and trap rock


MAINE
NEW HAMPSHIRE
VERMONT
MASSACHUSETTS
CONNECTICUT
LEGEND
▲ Limestone quarry
♦ Limestone quarry and limekiln
■ Sandstone quarry
● Marble quarry
) Slate quarry
x Granite quarry
✶ Trap rock quarry
Scale
Miles
74
73
72
71
70
69
68
67
47
46
45
44
43
42
41

MAP OF NEW ENGLAND STATES AND LONG ISLAND

Showing location of limekilns and quarries of limestone, sandstone, marble, slate, granite, and trap rock

Prepared under the direction of
E. F. Burchard

to the Survey. All quarries have therefore been plotted with reference to the nearest railroad station or post office, according to the reports of the producer, unless, as in many cases, special information in the possession of the writer has been drawn upon to settle doubtful locations. In view of the small scale of the map and the purposes which it is intended to fulfill it is not believed that these errors will detract seriously from its value.

The treatment of the subject in the following discussions has, on account of limitations of time and space, been very much generalized. In the case of the directories locations only have been given, without reference to ownership of quarries, since it is planned to treat this subject in an entirely impersonal way, and also because the ownership of quarries changes more or less frequently.

Readers who are interested in further details concerning the stone resources of the country will find much local information in the Survey reports listed in the bibliography at the end of this chapter, especially the works of Dale, Eckel, and Watson, and in a textbook by G. P. Merrill, "Stones for building and decoration," published by John Wiley & Sons, New York.

NEW ENGLAND STATES AND LONG ISLAND, N. Y.

Stone is the most important of the mineral resources of the New England States. The map (Pl. II) shows the wide distribution of New England granite, the extensive marble belt, and the localities where trap rock, sandstone, limestone, and slate are quarried, and where lime is made. The proximity of the populous New England cities and of New York, Philadelphia, and other seaboard cities to the New England granite and marble areas has been responsible in a large measure for the great development of the quarrying industry in that section. From Long Island Sound to the Bay of Fundy granite forms most of the coast line. That coast line is bold and rugged, with many small, deep bays or fiords and reaches, bordered by islands, affording shelter and sufficiently deep water for schooners built for the stone-carrying trade. Cliffs of granite that have been bared by glacial action and are washed by navigable waters are converted on the spot into rough building blocks or into paving blocks and dimension stone, and the products are loaded directly into boats bound for Boston, New York, or Washington. The marble areas of western Vermont and Massachusetts are easily accessible by railroads and are relatively near large markets. With the growth of the New England granite and marble industries and the consequent lowering of cost of production has come the extension of markets, so that to-day Maine granite and Vermont marble are sold in the Mississippi Valley and the Rocky Mountain States and even on the Pacific coast in competition with local products.

Limestone, lime, and marble.—Practically all the limestone in the New England States is so highly crystalline as to be considered marble. The principal areas of calcareous rocks are near the coast of Maine, in Knox and Waldo counties, and in western Vermont, Massachusetts, and Connecticut. Lime is the principal product of the Knox County, Me., area, and it is made on a large scale also in Berkshire County, Mass., and in Litchfield and Fairfield counties, Conn. In Vermont, also, the marble is suitable for the manufacture of lime, although that product falls below that of any of the above-mentioned States.

The marble of New England as reported here includes four types of stone. By far the most extensive deposits are of true marble, the distribution of which is outlined above. The Vermont true marbles are too well known to need description here. They consist of calcite and dolomite marbles, comprise white rock and such tints as cream, gray, bluish, and greenish, and are used for structural, decorative, ornamental, and statuary purposes. A Bulletin (No. 521) on the commercial marbles of western Vermont, by T. N. Dale, is now in press and will soon be issued by the Survey. The active quarries are located principally in Addison, Bennington, Orange, and Rutland counties. The three other types of rock commercially termed marble are quarried also in Vermont. One type is a dark-blue, dense, fine-grained fossiliferous limestone quarried on Isle La Motte, in Grand Isle County. This rock takes a high polish, becoming nearly black when polished, and is used much for interior decoration. Floor tiles are made from it, and the slabs are often sawed so that they display a section of a large coiled gastropod shell (*Maclurea magna*) on the surface of the tile. Another type of marble is a mottled red and white quartzose and argillaceous dolomite. It is quarried at Swanton, Franklin County, and is known as "Champlain marble." Besides various shades of red this rock also displays olive-greenish tints. It is very hard, taking a high polish, and is used chiefly for flooring and interior work. Stairways are built of it in many public buildings. The fourth type of stone, commercially styled marble, is not a marble at all, since it is not a calcareous rock. It is the so-called "verde antique marble" quarried at Roxbury, Washington County, Vt., and is in reality a serpentine. This "verde antique" is of a dark-green color, gashed and veined with white magnesite. It is very hard, but takes a fairly good polish, and its striking contrasts of dark green and white, and the irregularity of its veining, make it a very handsome stone for interior decoration. It is commonly used for bases of walls, for wainscoating, and for counters and fixtures in banks and offices. The extent of the marbles of Isle La Motte, Swanton, and Roxbury is slight compared to that of the true marbles of western Vermont. The belt of the latter rocks extends southward through Massachusetts where it is quarried at 10 or more places in Berkshire County, into Connecticut, where it is quarried at one place for marble. Southward through Connecticut the stone becomes much fractured, and is of value chiefly for the manufacture of lime.

Sandstone.—The sandstone of commercial value in New England is restricted chiefly to the Connecticut Valley in Connecticut and Massachusetts, but there is a small area of coarse conglomeratic sandstone south and west of Boston. The sandstone of the Connecticut Valley is of Triassic age. In color it ranges from red to brown, and is of medium fineness of grain. The once fashionable brownstone fronts in New York and other eastern cities bear evidence of the large extent to which this type of stone was formerly used. There is still a considerable production of sandstone from this area.

Slate.—Roofing slate in New England occurs principally in two areas, one in the counties of Piscataquis and Somerset, Me., the other in Rutland County, Vt., and there is a third area in Washington

County, Vt. Quarries have been active in recent years in all of these areas. Slate for roofing has been quarried also in Worcester County, Mass., and slate for road making and for rough building has been quarried in the vicinity of Boston and Cambridge, but the production of this grade of material is included under trap rock.

Granite.—Granite, as stated above, abounds along the New England coast, but it also extends well inland in the coast States, and also underlies much of the area of New Hampshire and Vermont. The granites of New England have been so thoroughly described in a series of Survey bulletins by T. N. Dale (see Bibliography) that whoever is interested in this subject is referred to these publications, which are distributed free. It is sufficient to comment here that granite is quarried in Maine in 13 counties out of a total of 16; in New Hampshire in 9 counties out of 10; in Vermont in 7 counties out of 14; in Massachusetts in 10 counties out of 14; in Rhode Island in 4 counties out of 5, and in Conecticut in 7 counties out of 8.

Trap rock.—The areas of commercial trap rock in New England are in northeastern Massachusetts, in the Connecticut Valley in Massachusetts and Connecticut, and in southwest Connecticut, and, in addition, on Plate II is indicated a locality in Queens County, on Long Island. Commercially, trap rock includes diabase, basalt, and any dark-colored, heavy igneous rock. Trap rock is used for rough masonry, foundations, harbor improvements, paving blocks, as crushed stone for ballast, macadam, and concrete, and where the stone is of suitable grain and will take a polish it has even been used for monumental work. There are no special Survey publications on trap rock, but in view of the importance of this material for the uses enumerated above it deserves more attention than it has hitherto received. The quarry map (Pl. II) shows the distribution of trap rock quarries, and roughly outlines the distribution of this material in southern New England.

Directory.—Quarries of all the kinds of rock produced in New England are listed below by State, class of rock, county, and town (or post office):

Directory of stone quarries in New England States and Long Island.

MAINE.

LIMESTONE.

Waldo County:
  1. Searsmont.

LIME AND LIMESTONE.

Knox County:
  1. Rockland (4).
  2. Rockport.
  3. Thomaston (5).
  4. Union.
  5. Warren.

SLATE.

iscataquis County:
  1. Brownville (2).
  2. Monson (4).
  3. Williamsburg (mail Henderson).
omerset County:
  4. The Forks.

MAINE—Continued.

GRANITE.

Aroostook County:
  1. Smyrna.
Cumberland County:
  2. Freeport.
  3. North Yarmouth (2).
  4. Portland (4).
  5. Pownal (2).
  6. Westbrook (3).
  7. Yarmouth.
Franklin County:
  8. Chesterville (2).
  9. Farmington Falls.
  10. North Jay (4).
  11. Phillips.
Hancock County:
  12. Bar Harbor (2).
  13. Blue Hill (3).
  14. Brooksville (3).
  15. Dedham.

Directory of stone quarries in New England States and Long Island—Continued.

MAINE—Continued.

GRANITE—continued.

Hancock County—Continued.
  16. Franklin, East Franklin, and West Franklin (13).
  17. Hall Quarry (8).
  18. Mount Desert.
  19. Northeast Harbor.
  20. Orland.
  21. Sedgwick.
  22. Southwest Harbor.
  23. Stonington (14).
  24. Sullivan, West Sullivan, and North Sullivan (9).
  25. Swans Island (2).
Kennebec County:
  26. Augusta (3).
  27. Hallowell (2).
  28. Wayne.
Knox County:
  29. Clark Island.
  30. Hurricane Isle (2).
  31. Long Cove.
  32. Rockland and South Thomaston (5).
  33. St. George.
  34. Vinal Haven (4).
Lincoln County:
  35. Round Pond.
  36. Waldoboro.
  37. Whitefield.
Oxford County:
  38. Bryant Pond.
  39. Fryeburg (2).
  40. Norway.
  41. Waterford.
  42. Welchville.
Somerset County:
  43. Canaan.
  44. Mainstream.
  45. Norridgewock (3) and South Norridgewock.
Waldo County:
  46. Frankfort (2).
  47. Lincolnville (2).
  48. Swanville.
Washington County:
  49. Addison.
  50. Calais (4).
  51. Charlotte.
  52. Jonesboro (3).
  52a. Jonesport.
  53. Marshfield (mail Machias).
  54. Millbridge.
  55. Red Beach (3).
York County:
  56. Alfred.
  57. Berwick.
  58. Biddeford (7).
  59. Kennebunkport.
  60. North Berwick.
  61. Sanford.

NEW HAMPSHIRE.

GRANITE

Carroll County:
  1. Conway (2).
  2. Redstone.
Cheshire County:
  3. Fitzwilliam (4).
  4. Marlboro.
  5. Troy (2).
Coos County:
  6. Groveton.
  7. Shelburne.
Grafton County:
  8. Benton.
  9. Canaan.
  10. Grafton.
  11. Hanover.
  12. Haverhill.
  13. Lebanon.
  14. Warren.
Hillsboro County:
  15. Amherst.
  16. Brookline (2) and South Brookline.
  17. Manchester (4).
  18. Mason.
  19. Milford (13) and East Milford.
  20. Nashua (2).
Merrimack County:
  21. Allenstown.
  22. Concord (9).
  23. Mount Sunapee.
Rockingham County:
  24. Portsmouth.
Strafford County:
  25. Dover.
  26. Durham (2.)
  27. Farmington.
  28. Rochester (2).
Sullivan County:
  29. Sunapee.

VERMONT.

LIMESTONE.

Chittenden County:
  1. Winooski (3).

LIME AND LIMESTONE.

Addison County:
  1. Leicester Junction (2).
  2. New Haven.
Bennington County:
  3. North Pownal (2).
Chittenden County:
  4. Burlington (3).
Franklin County:
  5. Highgate Springs.
  6. Swanton (3).
Rutland County:
  7. West Rutland.

Directory of stone quarries in New England States and Long Island—Continued.

VERMONT—Continued.

LIME AND LIMESTONE—continued.

Windham County:
  8. Sherman.
Windsor County:
  9. Amsden.

MARBLE.

Addison County:
  1. Bristol (2).
  2. North Ferrisburg.
Bennington County:
  3. Dorset (2).
  4. East Dorset (3).
  5. South Dorset.
Franklin County:
  6. Swanton.
Grand Isle County:
  7. Fisk.
  8. Isle La Motte.
Orange County:
  9. Waits River.
  10. Washington.
Rutland County:
  11. Brandon (3).
  12. Clarendon (2).
  13. Clarendon Springs.
  14. Danby.
  15. Pittsford.
  16. Proctor.
  17. Rutland.
  18. West Rutland (4).
Washington County:
  19. Roxbury.

SLATE.

Rutland County:
  1. Castleton (3).
  2. Fairhaven (20).
  3. Hydeville (3).
  4. Pawlet (7).
  5. Poultney (18) and North Poultney (2).
  6. South Poultney.
  7. Wells (6).
  8. West Castleton (2).
  9. West Pawlet (8).
Washington County:
  10. Northfield (4).

GRANITE.

Caledonia County:
  1. Groton (3).
  2. Hardwick (4).
  3. Kirby (4) (mail, Lyndon).
  4. Newark.
  5. South Ryegate (7).
Essex County:
  6. Island Pond.
  7. Concord.
Orange County:
  8. Chelsea.
  9. Randolph.
  10. Williamstown (2).

VERMONT—Continued.

GRANITE—continued.

Orleans County:
  11. Barton.
  12. Newport.
  13. North Derby.
Washington County:
  14. Barre (13) and East Barre (3).
  15. Cabot.
  16. Calais.
  17. Graniteville (7).
  18. Websterville (10).
  19. Woodbury (10).
Windham County:
  20. Grafton.
  21. West Dummerston (3).
Windsor County:
  22. Bethel (2).
  23. Windsor.

MASSACHUSETTS.

LIMESTONE.

Berkshire County:
  1. Dalton.

LIME AND LIMESTONE.

Berkshire County:
  1. Adams.
  2. Cheshire (2).
  3. Great Barrington.
  4. Lee (2).
  5. New Lenox.
  6. North Adams (2).
  7. Richmond.
  8. Sheffield (2).
  9. West Stockbridge (4).

SANDSTONE.

Hampden County:
  1. East Long Meadow (5).

MARBLE.

Berkshire County:
  1. Alford.
  2. Ashley Falls.
  3. Lee (3).
  4. North Adams.
  5. South Egremont.
  6. Stockbridge.
  7. West Stockbridge.
Hampden County:
  8. Westfield.

GRANITE.

Berkshire County:
  1. Becket.
  2. Chester (near).
  3. Lenox (2).
  4. Lenoxdale.
  5. Stockbridge.
Bristol County:
  6. Dartmouth and North Dartmouth.

Directory of stone quarries in New England States and Long Island—Continued.

MASSACHUSETTS—Continued.

GRANITE—continued.

Bristol County—Continued.
7. Fall River (10).
8. New Bedford (2) and near Mattapoisett.

Essex County:
9. Annisquam (2).
10. Beverly Farms.
11. Gloucester (2).
12. Lanesville (3).
13. Lawrence.
14. Lynn (2).
15. Lynnfield.
16. Manchester.
17. Peabody (5).
18. Pigeoncove.
19. Rockport (3).

Franklin County:
20. Shelburne Falls.
21. Warwick.

Hampden County:
22. Chester (2).
23. Monson.

Hampshire County:
24. Chesterfield.
25. Northampton.
26. Pelham.

Middlesex County:
27. Dunstable (3).
28. Graniteville (6).
29. Hopkinton.
30. North Acton (2).
31. North Chelmsford (2).
32. Waltham.
33. Westford (10).
34. West Townsend.
35. Winchester.

Norfolk County:
36. East Weymouth.
37. Quincy (15), East Milton, Gass Place, and West Quincy (6).
38. Wrentham.

Plymouth County:
39. Hingham (3).

Worcester County:
40. Dudley.
41. Fitchburg (5).
42. Leominster.
43. Milford (3) and North Milford.
44. Northbridge.
45. Uxbridge (2).
46. West Auburn.
47. Worcester (2).

TRAP ROCK.

Essex County:
1. Beverly.
2. Danvers.
3. Haverhill.
4. Lynn.
5. Methuen.
6. Newburyport.
7. Salem (2).

MASSACHUSETTS—Continued.

TRAP ROCK—continued.

Franklin County:
8. East Deerfield.

Hampden County:
9. Westfield.
10. West Springfield.

Hampshire County:
11. Amherst.

Middlesex County:
12. Arlington and Medford (2).
13. Newton.
14. Somerville (3).
15. Weston.
16. Woburn and Winchester (2).

Norfolk County:
17. Cohasset.
18. North Stoughton.
19. Quincy.

Plymouth County:
20. Hingham.

Suffolk County:
21. Boston.
22. Franklin Park.
23. West Roxbury.

Worcester County:
24. Sterling.

RHODE ISLAND.

LIME AND LIMESTONE.

Providence County:
1. Limerock.

GRANITE.

Kent County:
1. Coventry.

Newport County:
2. Middletown.
3. Newport (5).

Providence County:
4. Central Falls, Pawtucket, and Saylesville.
5. East Providence.
6. Pascoag and Burrillville.
7. Stillwater.

Washington County:
8. Charlestown.
9. Niantic and Westerly (8).
10. Wickford.

CONNECTICUT.

LIME AND LIMESTONE.

Fairfield County:
1. Bethell (2).
2. Brookfield.
3. Danbury.
4. Redding.

Litchfield County:
5. Canaan (4) and East Canaa (3).
6. New Milford.

Directory of stone quarries in New England States and Long Island—Continued.

CONNECTICUT—Continued.

SANDSTONE.

Hartford County:
1. Avon.
2. Buckland.
3. Tariffville.

Middlesex County:
4. Portland.

New Haven County:
5. Easthaven (2).
6. New Haven (3).

MARBLE.

Litchfield County:
1. Canaan.

GRANITE.

Fairfield County:
1. Bridgeport (4).
2. Danbury.
3. Greenwich (3).
4. Norwalk.

Hartford County:
5. East Glastonbury (2).
6. Glastonbury (5).
7. South Manchester.

Litchfield County:
8. Roxbury Station.
9. Thomaston.
10. Torrington (3) and West Torrington (1).

Middlesex County:
11. Essex.
12. Haddam.

New Haven County:
13. Ansonia (4), Seymour (2), and East Derby (1).
14. Branford.
15. Leete Island.
16. North Branford.
17. Sachem Head (2).
18. Stony Creek (4).
19. Wallingford.

CONNECTICUT—Continued.

GRANITE—continued.

New London County:
20. Center Groton (2).
21. East Lyme.
22. Groton (3).
23. Mystic (2) and West Mystic (1).
24. Niantic (2).
25. New London (2) and Waterford (3).
26. Quaker Hill.
27. Stonington and Pawcatuck.

Windham County:
28. Oneco (2) and Sterling (2).
29. Plainfield.
30. Willimantic.

TRAP ROCK.

Fairfield County:
1. Bridgeport.
2. New Canaan.

Hartford County:
3. New Britain (2).
4. Newington.
5. Plainville.
6. Rocky Hill.
7. Tariffville.

Litchfield County:
8. Winchester (mail Winsted).

New Haven County:
9. Ansonia.
10. East Haven (2).
11. Meriden.
12. Milford.
13. Mount Carmel (2).
14. New Haven.
15. North Branford.

LONG ISLAND, N. Y.

TRAP ROCK.

Queens County:
2. Richmond Hill.

NEW YORK, NEW JERSEY, AND PENNSYLVANIA.

The stone quarries in New York, New Jersey, and Pennsylvania are so numerous that the attempt to place them all on a single map of the scale used in this report would have resulted in such overcrowding and in such deviation from accurate location that it was found best to show the limestone quarries and limekilns on one map and the other stone quarries on a second map (Pls. III and IV). The whole range of stone-quarry products are to be found in these States, although marble is rare.

Limestone and lime.—New York and Pennsylvania are both especially rich in limestone beds. A belt of Silurian limestones extends eastward from Buffalo nearly across New York, and adjoining this belt on the south are Devonian formations which also carry limestones. On account of the proximity of these limestone areas to several east-west railroads and of the exceptional purity of the stone, they are extensively quarried, especially for flux for blast furnaces at Buffalo. East of Lake Ontario, in addition to a lobe of Silurian limestone, there is an area of Ordovician rock which yields limestone in the vicinity of Watertown. Along St. Lawrence River and the northern end of Lake Champlain, Cambrian and Lower Ordovician limestones occur, and quarries are operated in the vicinity of Ogdensburg and Plattsburg. Lime is burned at many of these localities in New York, but, as the map (Pl. III) shows, the lime industry is much more widely distributed in Pennsylvania than in New York. Many of the limekilns in Pennsylvania, however, are small affairs, operated intermittently to furnish lime for local fertilizers. In Pennsylvania limestones of commercial value occur in the western half of the State in the Carboniferous areas, and chiefly in the Pennsylvanian ("Coal Measures") formations. From the middle of the State eastward the limestones are chiefly of late Cambrian, Ordovician, Silurian, and Devonian age, and the limestone areas are distributed in long, narrow strips, analogous to the outcrops of the "valley" limestones in the southern Appalachians. The dips of the beds in eastern Pennsylvania are steep as compared with those in the western half of the State. Much of the New York limestone, especially in the western half of the State, is high in calcium carbonate; in Pennsylvania both high-calcium and high-magnesium stone occurs in abundance, the magnesian rock being especially well represented in the valleys of southeastern Pennsylvania. The "cement" rock and purer limestone beds of the Lehigh district in eastern Pennsylvania are quarried to some extent for crushed stone. Near Philadelphia the limestone has been subjected to intense folding and pressure, and in many places the beds have been recrystallized to marble, although they are utilized mostly for lime rather than for marble. In northwest New Jersey the beds utilized for crushed stone in the Lehigh district of Pennsylvania extend into Warren, Sussex, and Hunterdon counties, N. J. Much of this rock is highly magnesian. As is well shown by the maps (Pls. III and IV), the stone area in New Jersey is limited to the northwestern and northern part of the State. This is explained by the fact that the deposits of the Coastal Plain, which underlie the remainder of the State, are composed of but feebly consolidated materials, such as clay and sand.

Marble.—True marble is not widely distributed in either New York or Pennsylvania. In New York there are deposits in Westchester County of a white and gray, coarsely crystalline dolomite, and it is reported[1] that one of the belts of this stone reaches Manhattan Island, crossing Harlem River at Kings Bridge. There are also deposits in St. Lawrence County of a coarsely crystalline, light-gray magnesian marble, and in Dutchess County, near the Connecticut line, are quarries of coarse white dolomite marble. In Pennsylvania, as mentioned above, true marble occurs in the southeastern part of the State, and the most noteworthy belt of this material extends northeastward from the southern part of Lancaster County across Chester County, well into Montgomery County. There are a few marble quarries in these areas in both New York and Pennsylvania. The prevailing colors of the stone throughout the larger part of the southeastern Pennsylvania area are yellowish and bluish,

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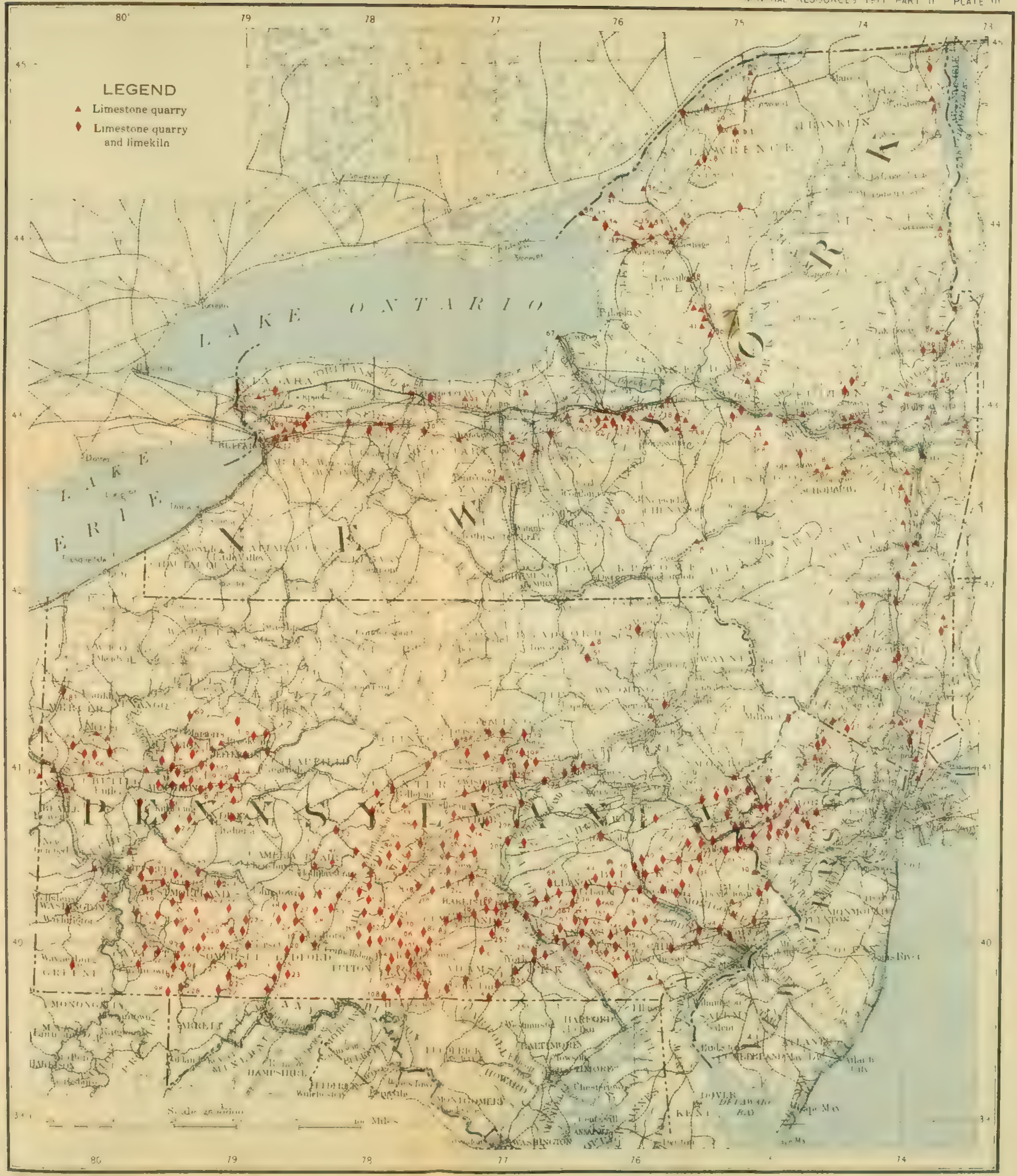
[1] Merrill, G. P., Stones for building and decoration, 1897, p. 97.

Fairmont
Grafton
HARRISON
Clarksburg
ATLANTIC
Mays Landing
Atlantic City
Cape May
Cape May
39°
39°
25
80°
75°
74°

ENGRAVED AND PRINTED BY THE U.S.GEOL

Prepared under the direction of
E. F. Burchard

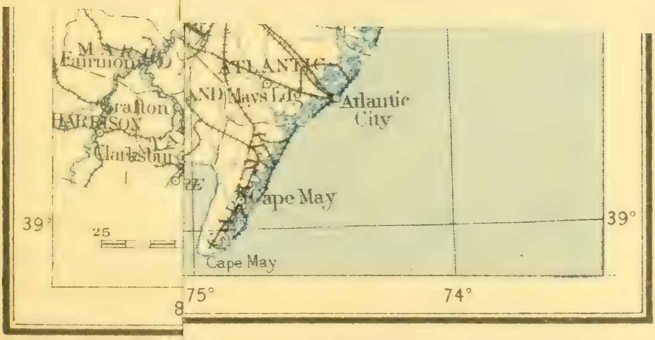
U. S. GEOLOGICAL SURVEY
GEORGE OTIS SMITH, DIRECTOR


LEGEND
▲ Limestone quarry
♦ Limestone quarry and limekiln
80°
79
78
77
76
75
74
73
45
44
43
42
41
40
39
LAKE ONTARIO
LAKE ERIE
NEW YORK
PENNSYLVANIA
NEW JERSEY
ST. LAWRENCE
FRANKLIN
BUFFALO
BALTIMORE
WASHINGTON
HARFORD
MONTGOMERY
DOVER
DELAWARE BAY
KENT
Miles

MAP OF NEW YORK, PENNSYLVANIA, AND NEW JERSEY

Showing location of limestone quarries and limekilns

Prepared under the direction of E. F. Burchard


MARION
Fairmont
Grafton
HARRISON
Clarksburg
ATLANTIC
CUMBERLAND
Mays Ldg
Atlantic City
CAPE MAY
Cape May
Cape May
39°
39°
25
75°
74°
8

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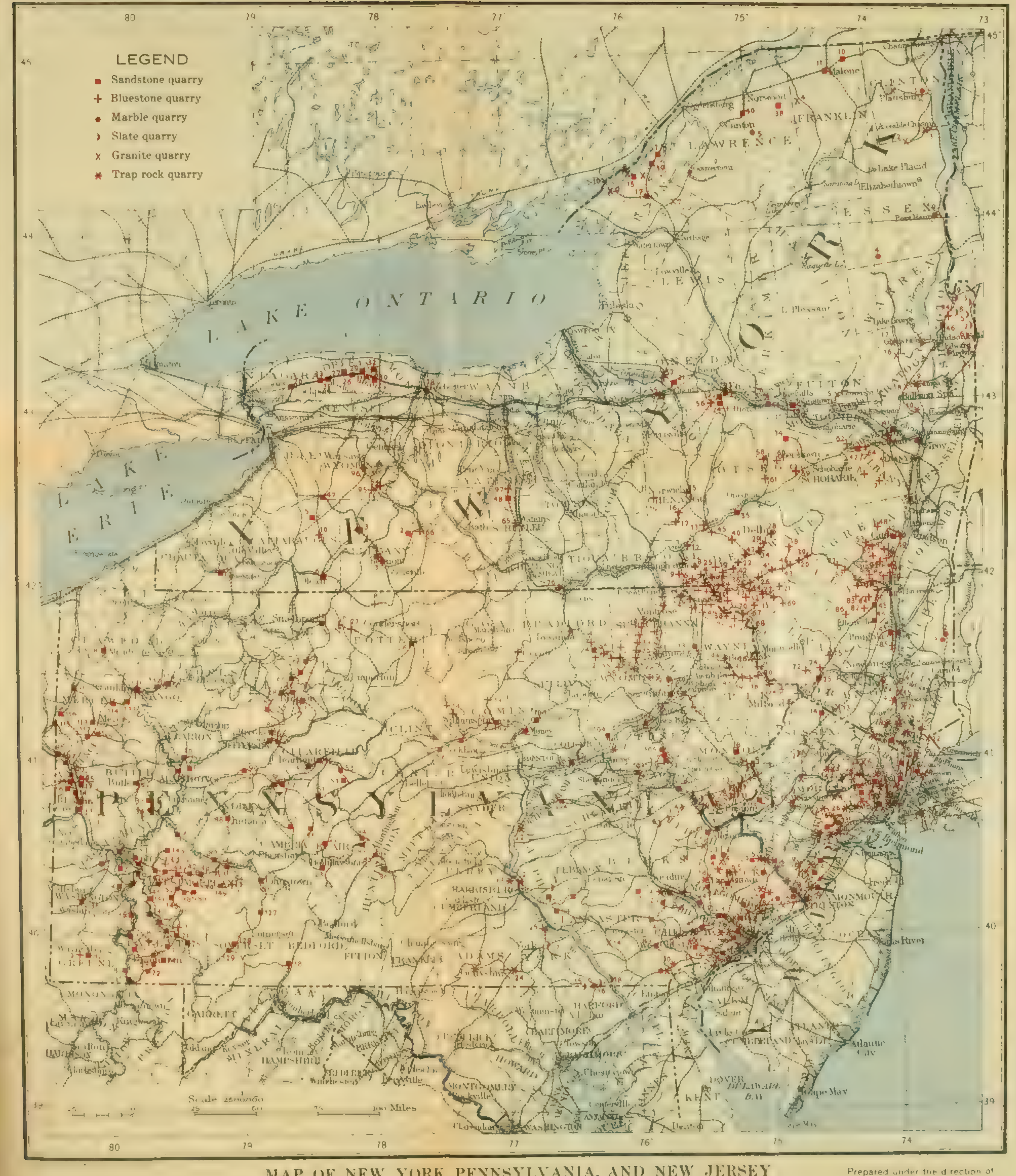
rock


LEGEND
■ Sandstone quarry
+ Bluestone quarry
● Marble quarry
) Slate quarry
x Granite quarry
✱ Trap rock quarry
LAKE ONTARIO
LAKE ERIE
NEW YORK
PENNSYLVANIA
Scale 1:2500000
100 Miles

MAP OF NEW YORK, PENNSYLVANIA, AND NEW JERSEY
Showing location of quarries of sandstone, bluestone, marble, slate, granite, and trap rock

Prepared under the direction of
E. F. Burchard

clouded shades, rendering the stone not especially desirable for building purposes; but in an area of highly metamorphosed rocks between Brandywine and Wissahicken creeks the stone is granular crystalline and contains white as well as veined marble.

In New York there are several localities in which the limestones outlined above are of pleasing colors and of such a texture that they will take a fine polish, and the products are commercially styled marbles. This type of marble is found in Clinton County, near Plattsburg, in Essex County, and in Ward County, at Glens Falls.

Sandstone (*including bluestone*).—Inspection of the map (Pl. IV) shows sandstone quarries distributed with more or less irregularity throughout New York, except in the Adirondack region, where the rocks are mainly crystalline; in New Jersey there are a few quarries near the southeast border of the hard-rock area; and in Pennsylvania they are fairly numerous except in the Appalachian region, where, although there may be an abundance of sandstone, the beds may not be particularly accessible.

The rock popularly known as "bluestone" in southern New York and northeastern Pennsylvania is a fine-grained, compact, dark blue-gray, argillaceous sandstone. This rock is of Devonian age. Owing to the fact that it occurs usually in thin beds and splits out readily in slabs but a few inches thick, it is used extensively for flagging, curbs, sills, caps, steps, etc. Most of the quarries are small and are worked by their owners, local farmers. Collectively, this quarrying forms an important industry . The map (Pl. IV) shows the grouping of these quarries in Delaware, Ulster, and Sullivan counties, N. Y., and in Bradford, Susquehanna, Wayne, and Wyoming counties, Pa., as well as a few quarries in outlying areas. The sandstone other than bluestone in New York occurs mainly in Cambrian, Ordovician, and Silurian formations; in western Pennsylvania it occurs in Carboniferous rocks; and in eastern Pennsylvania and New Jersey the Triassic rocks afford large quantities of reddish-brown to dark-brown sandstone. The belt of Triassic sandstone extends from Rockland County in the southern corner of New York, southwestward across parts of Bergen, Hudson, Essex, Passaic, Somerset, Hunterdon, and Mercer counties, N. J., parts of Bucks, Berks, Lebanon, and Dauphin counties, Pa., and southward into Maryland.

Slate.—The productive slate area in New York is confined to Washington County, and is a continuation of the Rutland County (Vt.) area. Formations of two distinct systems afford slate—the lower Cambrian, which contains greenish and purplish material, and the Ordovician, which contains isolated areas of red and green slate.

In Pennsylvania slate occurs in two areas, one in Lehigh and Northampton counties, the other in Lancaster and York counties. The first-mentioned area extends into Sussex and Warren counties, N. J. The rocks of this belt are of Ordovician age. The principal quarrying centers in Pennsylvania are Slatington, Lehigh County, and Bangor and Pen Argyle, Northampton County. The slate obtained at Bangor and Pen Argyle is very dark gray in color, and that at Slatington is very dark bluish gray.

The slate of the second area mentioned above is termed the Peach Bottom slate. The product of this area is very dark gray in color, with a slightly bluish tinge. The rock is so highly crystalline as to be considered quite a durable slate.

For details as to these various slates the reader is referred to Survey Bulletin 275, which may be purchased from the Superintendent of Documents, Washington, D. C., for 15 cents. A revised edition, for free distribution, is in preparation.

Granite.—The productive granite areas of this group of States are limited. In New York they are confined to the northern and eastern part of the State, around the border of the Adirondack uplift, and to the crystalline area in the southern corner of the State. Quarries are operated in 10 counties, as follows: Clinton, Essex, Franklin, Fulton, Herkimer, Jefferson, Orange, Putnam, Saratoga, and Westchester, but the products are mostly used within the State. Gray granite is quarried in Orange County, and red granite, used in decorative and monumental work, is quarried on Grindstone Island in St. Lawrence River, Jefferson County.

The New Jersey granite area is in the highlands of the State, where the belt of crystalline rock is a southwestward extension from Orange County, N. Y. The principal quarries are in Morris and Passaic counties.

Pennsylvania, although a great stone-producing State, does not possess extensive supplies of high-grade granite. Under granite quarries in Pennsylvania are included the quarries of gneiss which are operated to supply local needs for foundation stone, rough masonry, road ballast, etc. There are quarries in the following seven counties, which contain nearly all the crystalline area of the State: Berks, Bucks, Chester, Delaware, Lancaster, Lehigh, and Montgomery.

Trap rock.—New York, New Jersey, and Pennsylvania are among the largest producers of trap rock, not because this class of rock is widely distributed, but because there are certain large areas of it situated very near the cities of New York, Jersey City, and Philadelphia, as, for instance, in New York County, Queens County, and Rockland County, N. Y., along the Palisades of Hudson River, and in nearly all the counties of northern New Jersey between Jersey City and Trenton, as well as in the southeastern Pennsylvania counties listed above, which contain gneiss and other crystalline rocks. Notes have been given on the character and uses of trap rock in the chapter on the New England States.

Directory.—Quarries of all the kinds of rock produced in New York, New Jersey, and Pennsylvania are listed below, by State, class of rock, county, and town (or post office):

Directory of stone quarries in New York, New Jersey, and Pennsylvania.

NEW YORK.

LIMESTONE.

Albany County:
  1. Normansville.
  2. South Bethlehem.
Cayuga County:
  3. Hamburg (probably near Union Springs).
Chenango County:
  4. East Guilford.
Clinton County:
  5. Bluff Point.
  6. Champlain (2).
  7. Plattsburg (3).

NEW YORK—Continued.

LIMESTONE—continued.

Columbia County:
  8. Hudson (3).
  9. Livingston.
Cortland County:
  10. Marathon.
Dutchess County:
  11. Stoneco.
  12. Wassaic.
Erie County:
  13. Bowmansville.
  14. Buffalo (10).
  15. Clarence (3).

Directory of stone quarries in New York, New Jersey, and Pennsylvania—Con.

NEW YORK—Continued.

LIMESTONE—continued.

Erie County—Continued.
  16. Depew (4).
  17. Lancaster.
  18. Wilhelm.
  19. Williamsville (3).
Essex County:
  20. Port Henry.
Genesee County:
  21. Batavia.
  22. Lime Rock.
Greene County:
  23. Climax.
Herkimer County:
  24. Jordanville.
  25. Little Falls (2).
  26. Newport (3).
  27. Norway.
Jefferson County:
  28. Black River.
  29. Carthage.
  30. Cape Vincent.
  31. Clayton (4).
  32. Dexter (3).
  33. Evans Mills.
  34. Herring.
  35. Pamelia (2).
  36. Theresa (2).
  37. Three Mile Bay.
Lewis County:
  38. Lowville (6).
  39. Lyons Falls.
  40. Port Leyden (2).
  41. Talcottville.
  42. Turin.
Madison County:
  43. Munnsville.
  44. Oneida.
  45. Perryville (3).
Monroe County:
  46. Rochester (3).
Montgomery County:
  47. Akin.
  48. Amsterdam (4).
  49. Fort Hunter.
  50. Minden.
  51. St. Johnsville (3).
  52. Tribes Hill.
Niagara County:
  53. Lewiston (2).
  54. Niagara Falls (3).
  55. Sanborn.
Oneida County:
  56. Boonville.
  57. Knoxboro (2).
  58. Oriskany Falls (2).
  59. Prospect (2) and Remsen.
Onondaga County:
  60. East Onondaga (4).
  61. Marcellus (3).
  62. Onondaga Castle (3).
  63. Skaneateles.
  64. Syracuse (2).

NEW YORK—Continued.

LIMESTONE—continued.

Ontario County:
  65. Canandaigua.
Orange County:
  66. Pine Island.
Oswego County:
  67. Oswego.
Otsego County:
  68. Springfield Center.
Rensselaer County:
  69. Hoosick Falls (2).
  70. Troy.
Rockland County:
  71. Tompkins Cove.
St. Lawrence County:
  72. Lisbon.
  73. Massena.
  74. Norwood.
  75. Richville.
Saratoga County:
  76. Rock City Falls.
  77. Saratoga Springs.
  78. Schuylerville.
  79. Stillwater.
Schenectady County:
  80. Pattersonville (2).
Schoharie County:
  81. Barnerville.
  82. Cobleskill (6).
  83. Schoharie.
Seneca County:
  84. Waterloo (2).
Ulster County:
  85. Ellenville.
Washington County:
  86. Adamsville.
  87. Bald Mountain.
  88. Fort Ann.
  89. Sandy Hill (3).
  90. Smiths Basin.
  91. Whitehall.
Wayne County:
  92. Butler (probably Butler Center).
  93. Walworth.
Westchester County:
  94. Elmsford.
  95. Tuckahoe.
  96. Verplanck.
Yates County:
  97. Dresden.

LIME AND LIMESTONE.

Albany County:
  1. Ravena (3).
Cayuga County:
  2. Auburn (7).
Clinton County:
  3. Chazy.

Directory of stone quarries in New York, New Jersey, and Pennsylvania—Con.

NEW YORK—Continued.

LIME AND LIMESTONE—continued.

Dutchess County:
  4. Dover Plains.
  5. Poughkeepsie.
Erie County:
  6. Akron (4).
  7. Millgrove.
Fulton County:
  8. Cranberry Creek.
  9. Mayfield (2).
Genesee County:
  10. Le Roy (3).
Greene County:
  11. Catskill (3).
Herkimer County:
  12. Litchfield (mail Frankfort).
  13. North Litchfield.
Jefferson County:
  14. Chaumont (2).
  15. Natural Bridge.
  16. Watertown (6).
Livingston County:
  17. Caledonia.
Madison County:
  18. Valley Mills.
Monroe County:
  19. Brighton.
  20. Honeoye Falls.
Niagara County:
  21. Lockport (12).
Onondaga County:
  22. Fayetteville (2).
  23. Jamesville (6).
  24. Manlius (4).
  25. Onondaga.
Orange County:
  26. Newburgh.
  27. Warwick (2).
St. Lawrence County:
  28. Bigelow.
  29. Canton (2).
  30. Crarys Mills.
  31. Ogdensburg (4).
  32. Oswegatchie.
Schoharie County:
  33. Sharon Springs (2).
Seneca County:
  34. Fayette.
Ulster County:
  35. Accord.
  36. Katsbaan (R. D. from Saugerties).
  37. Kingston (4).
  38. Marbletown.
  39. Napanoch.
  40. Wawarsing.
Warren County:
  41. Glens Falls (8).
Westchester County:
  42. Ossining (2).
  43. Yorktown Heights.

NEW YORK—Continued.

SANDSTONE.

Albany County:
  1. Cohoes.
Allegany County:
  2. Almond.
  3. Belfast.
  4. Belmont.
Cattaraugas County:
  5. Machias.
  6. Olean (3).
Chautauqua County:
  7. Jamestown.
Dutchess County:
  8. Poughkeepsie.
Essex County:
  9. Port Henry.
Franklin County:
  10. Burke (2).
  11. Malone.
Greene County:
  12. Catskill.
  13. New Baltimore.
Herkimer County:
  14. Little Falls.
Jefferson County:
  15. Alexander Bay (2).
  17. Theresa.
Monroe County:
  18. Rochester (2).
Montgomery County:
  19. St. Johnsville.
Niagara County:
  20. Lockport.
Oneida County:
  21. Higginsville.
  22. New Hartford.
  23. Utica (2).
  24. Washington Mills.
Orange County:
  25. Otisville.
Orleans County:
  26. Albion (6).
  27. Eagle Harbor.
  28. Fancher.
  29. Hindsburg.
  30. Holley (3).
  31. Medina (5).
  32. Murray.
  33. Shelby Basin (3).
Otsego County:
  34. Cherry Valley.
  35. Otego.
Rockland County:
  36. Nanuet.
St. Lawrence County:
  37. Hammond (4).
  38. Hopkinton (4).
  39. Oakvale and South Hammond.
  40. Potsdam (2).
Schenectady County:
  41. Craig.
  42. Duanesburg.

Directory of stone quarries in New York, New Jersey, and Pennsylvania—Con.

NEW YORK—Continued.

SANDSTONE—continued.

Ulster County:
  43. Highland.
  44. New Paltz.
  45. Rosendale.
Washington County:
  46. Fort Ann (2).
Wyoming County:
  47. Arcade.
Yates County:
  48. Himrod.

BLUESTONE.

Albany County:
  1. Berne (2).
  2. Reidsville (2).
Allegany County:
  3. Scio.
Broome County:
  4. Deposit (13).
  5. East Windsor (2).
  6. Gulf Summit (3).
  7. McClure Settlement.
  8. Sanford (2).
  9. Windsor.
Cattaraugus County:
  10. Franklinville.
Chenango County:
  12. Afton.
  13. East Guilford (3).
  14. McDonough.
  15. Norwich (5).
  16. Oxford (4).
  17. South Oxford.
Delaware County:
  18. Andes.
  19. Apex (2).
  20. Arena.
  21. Beaverkill (near).
  22. Beerston (2).
  23. Burnwood (6).
  24. Cadosia.
  25. Cannonsville (2).
  26. Colchester.
  27. Cooks Falls (11).
  28. Delhi.
  29. De Lancey (3).
  30. Fishs Eddy (17).
  31. French Woods.
  32. Goulds (2).
  33. Hale Eddy (2).
  34. Hamden (2).
  35. Hancock (24).
  36. Harvard (2).
  37. Kelsey.
  38. Lordville (5).
  39. Margaretville (2).
  40. Merrickville.
  41. Pepacton (4).
  42. Rock Rift.
  43. Shavertown (2).
  44. Shinhopple (7).
  45. South Unadilla.

NEW YORK—Continued.

BLUESTONE—continued.

Delaware County—Continued.
  46. Union Grove (3).
  47. Walton (7).
Greene County:
  48. Acra (2).
  49. Catskill (2).
  50. Haines Falls.
  51. Palenville (6).
  52. Platt Clove (3).
  53. Tannersville.
Livingston County:
  54. Oakland.
Madison County:
  55. Canastota.
Oneida County:
  56. Clinton.
  57. Fishcreek.
Otsego County:
  58. Cooperstown.
  59. East Worcester.
  60. Middlefield.
  61. Milford.
Schenectady County:
  62. Duanesburg.
  63. Schenectady (3).
Schoharie County:
  64. Esperance (3).
Schuyler County:
  65. Watkins (2).
Steuben County:
  66. Hornell.
Sullivan County:
  67. Acidalia.
  68. Callicoon.
  69. Livingston Manor (14).
  70. Long Eddy (8).
  71. Narrowsburg.
  72. Oakland Valley.
  73. Roscoe (2).
  74. Westbrookville.
  75. Wurtsboro.
Tioga County:
  76. Waverly.
Ulster County:
  77. Allaben (2).
  78. Brodhead (4).
  79. Highwoods (9) (R. D. from Mount Marion).
  80. Hurley (3).
  81. Kingston (2).
  82. Kripplebush.
  83. Krumville.
  84. Marbletown (2).
  85. Marlboro.
  86. Mombaccus.
  87. Phoenicia.
  88. Quarryville (13).
  89. Ruby (6).
  90. Saugerties (49).
  91. West Hurley (6).
  92. West Saugerties (6).
  93. Woodstock (11).

Directory of stone quarries in New York, New Jersey, and Pennsylvania—Con.

NEW YORK—Continued.

BLUESTONE—continued.

Washington County:
   94. Comstock.
Wyoming County.
   95. Portageville.
   96. Rock Glen (2).
Yates County:
   97. Himrod.

MARBLE.

Clinton County:
   1. Plattsburg.
Dutchess County:
   2. South Dover (2).
   3. Wingdale.
Essex County:
   4. Minerva.
St. Lawrence County:
   5. Colton (2).
   6. Gouverneur (6).
Warren County:
   7. Glens Falls.
Westchester County:
   8. Ossining.
   9. Tuckahoe.

SLATE.

Washington County:
   1. Argyle.
   2. Granville (6).
   3. Hampton.
   4. Hebron.
   5. Middle Granville (2).
   6. North Hebron.
   7. Salem.
   8. West Granville (mail West Granville Corners).
   9. Whitehall (2).

GRANITE.

Clinton County:
   1. Dannemora.
Essex County:
   2. Ausable Forks (3).
   3. Keeseville (2).
Franklin County:
   4. St. Regis Falls.
Fulton County:
   5. Gloversville (2).
Herkimer County:
   6. Little Falls (2).
Jefferson County:
   7. Antwerp.
   8. Alexandria Bay (2).
   9. Clayton (2).
   10. Grindstone and Grindstone Island (4).
   11. Redwood.
Orange County:
   12. Cornwall.
   13. Pine Island.
Putnam County:
   14. Cold Spring.
   15. Garrison.

NEW YORK—Continued.

GRANITE—continued.

Saratoga County:
   16. Corinth.
   17. Hadley.
   18. Saratoga Springs.
Westchester County:
   19. Ardsley and Glenville.
   20. New Rochelle (2).
   21. Peekskill (4).
   22. Valhalla.
   23. Yonkers (5), Hastings, and Tuckahoe.

TRAP ROCK.

New York County:
   1. New York City.
Queens County:
   2. Richmond Hill (see also Plate II).
Rockland County:
   3. Haverstraw.
   4. Jonespoint.
   5. Mount Ivy.
   6. Nyack (2).
   7. Rockland Lake (2).
   8. Suffern.
Saratoga County:
   9. Saratoga Springs.
   10. Stillwater.

NEW JERSEY.

LIMESTONE.

Hunterdon County:
   1. Holland.
Somerset County:
   2. Gladstone.
Sussex County:
   3. Andover.
   4. Ogdensburg (2).
   5. Sparta Junction.
Warren County:
   6. Belvidere.
   7. Changewater.
   8. Hackettstown.
   9. Phillipsburg (2).

LIME AND LIMESTONE.

Hunterdon County:
   1. Annandale (2).
   2. Bloomsbury.
   3. Califon (2) and Vernoy (2).
   4. Junction.
   5. Jutland.
   6. Lebanon (3).
   7. Milford.
   8. New Germantown (2).
Morris County:
   9. Crestmoor (mail Milddle Valley).
   10. Mendham.
Somerset County:
   11. Peapack (2).

Directory of stone quarries in New York, New Jersey, and Pennsylvania—Con.

NEW JERSEY—Continued.

LIME AND LIMESTONE—continued.

Sussex County:
12. Hamburg (3).
13. McAfee (2).
14. Montague (2).

Warren County:
15. Beatyestown.
16. Blairstown (2).
17. Bridgeville.
18. Carpentersville (2) and Finesville.
19. Pequest.
20. Port Murry.

SANDSTONE.

Bergen County:
1. Closter (3).
2. Ridgefield (2).

Essex County:
3. Pleasantdale.

Hudson County:
4. North Arlington.

Hunterdon County:
5. Byram and Stockton.

Mercer County:
6. Lawrenceville.
7. Princeton (3).
8. Trenton.
9. Wilburtha.

Passaic County:
10. Passaic and Paterson.

Somerset County:
11. Kingston.
12. Martinsville.
13. Watchung.

Sussex County:
14. Quarryville (2).

Warren County:
15. Belvidere.

SLATE.

Sussex County:
1. Lafayette.
2. Newton.

Warren County:
3. Delaware Water Gap (mail Dunfield).
4. Port Murry.

GRANITE.

Morris County:
1. Boonton.
2. German Valley (3) and Middle Valley (2).
3. Hibernia.
4. Morristown (2).
5. Stanhope (near).

Passaic County:
6. Pompton (3).

TRAP ROCK.

Bergen County:
1. Cliffside, Cliffside Park, Edgewater, and Fairview.

NEW JERSEY—Continued.

TRAP ROCK—continued.

Essex County:
2. Caldwell (2) and Verona.
3. Milburn.
4. Montclair and Upper Montclair.
5. South Orange (2) and West Orange (4).

Hudson County:
5a. Granton.
6. Jersey City.

Hunterdon County:
7. Byram.
8. Lambertville (2).

Mercer County:
9. Hopewell.
10. Lawrenceville.
11. Princeton (2).
12. Titusville.

Middlesex County:
13. Dunellen.

Morris County:
14. Hibernia.
15. Middle Valley.
16. Millington.
17. Mountain View (near).
18. Pine Brook.
19. Pompton.

Passaic County:
20. Passaic.
21. Paterson (9).

Somerset County:
22. Bernardsville.
23. Bound Brook (2).
24. Rocky Hill.
25. Somerville.

Union County:
26. New Providence.

PENNSYLVANIA.

LIMESTONE.

Allegheny County:
1. Carnegie.
2. Verona.
3. Wilmerding.

Armstrong County:
4. Apollo.
5. Kaylor.

Beaver County:
6. Ellwood City (near).

Blair County:
7. Altoona.

Bradford County:
8. Camptown.

Bucks County:
9. Line Lexington.
10. Point Pleasant.

Butler County:
11. Harrisville.
12. Paynes (mail Portersville).

Center County:
13. Pleasant Gap.

Chester County:
14. Avondale.

Directory of stone quarries in New York, New Jersey, and Pennsylvania—Con.

PENNSYLVANIA—Continued.

LIMESTONE—continued.

Huntingdon County:
  15. Huntingdon.
  16. McConnellstown.
Jefferson County:
  17. Baxter (3).
  18. Brookville (3).
Lawrence County:
  19. Bessemer.
  20. Hillsville (4).
  21. New Castle.
Luzerne County:
  22. Exeter.
Mercer County:
  23. Grove City.
  24. Sharon.
Monroe County:
  25. Stroudsburg.
Montgomery County:
  26. North Wales.
Somerset County:
  27. Rockwood.

LIME AND LIMESTONE.

Adams County:
  1. Bittinger (2).
  2. Fairfield (2).
  3. Gettysburg.
  4. Littlestown (4).
  5. York Springs (3).
Allegheny County:
  6. Epton.
Armstrong County:
  7. Cochran Mills.
  8. Dayton (8).
  9. Deanville (6).
  10. Elderton.
  11. Ford City (3).
  12. Goheenville (7).
  13. Kittanning (5).
  14. Mahoning and Mosgrove (2).
  15. North Freedom.
  16. Putneyville (3).
  17. Sherrett (2).
Bedford County:
  18. Alumbank (2).
  19. Bedford (5).
  20. Buffalo Mills (6).
  21. Cessna (5).
  22. Cooks Mills.
  23. Cumberland Valley.
  24. Everett (14).
  25. Fossilville (2).
  26. Hyndman (5).
  27. Imler.
  28. Loysburg (3).
  29. New Paris (9).
  30. Saxton.
Berks County:
  31. Bechtelsville.
  32. Bernville (6).
  33. Fleetwood (3).
  34. Greshville.

PENNSYLVANIA—Continued.

LIME AND LIMESTONE—continued.

Berks County—Continued.
  35. Kutztown (5).
  36. Leesport.
  37. Limekiln (4).
  38. Lorane.
  39. Morgantown (2).
  40. Moselem.
  41. Reading (12).
  42. Robesonia (10).
  43. Sinking Spring (3).
  44. Stouchsburg.
  45. Temple.
Blair County:
  46. Canoecreek.
  47. Claysburg (5).
  48. Hollidaysburg.
  49. Martinsburg (2).
  50. Tyrone Forge.
Bradford County:
  51. Terrytown and Wyalusing (2).
Bucks County:
  52. Durham.
  53. Holicong.
  54. New Hope.
Butler County:
  55. Branchton (2).
  56. Slippery Rock (3).
  57. West Winfield.
Center County:
  58. Bellefonte (3).
  59. Benore.
  60. Fleming.
Chester County:
  61. Downington (2).
  62. Mill Lane Station.
  63. Phoenixville.
Clarion County:
  64. Bela.
  65. Burma.
  66. Frampton (4).
  67. Frogtown.
  68. Lawsonham.
  69. Lucinda (2).
Clearfield County:
  70. Dubois.
Clinton County:
  71. Lock Haven.
  72. Salona (2).
Columbia County:
  73. Almedia.
  74. Bloomsburg (3).
  75. Lime Ridge.
Cumberland County:
  76. Bowmansdale (3).
  77. Camp Hill.
  78. Carlisle (5).
  79. Elliottson and Greason.
  80. Hogestown.
  81. Mechanicsburg (4).
  82. Middle Spring (2).
  83. Newville.
  84. Shippensburg (8).

Directory of stone quarries in New York, New Jersey, and Pennsylvania—Con.

PENNSYLVANIA—Continued.

LIME AND LIMESTONE—continued.

Dauphin County:
85. Harrisburg.
86. High Spire.
87. Hummelstown (6).
88. Palmyra (near).
89. Pillow.

Fayette County:
90. Dunbar.
91. Freed.
92. Laurelhill.
93. Mill Run (3).
94. Nicolay.
95. Normalville.
96. Ohiopyle.
97. Pletcher (mail Champion).
98. Tissue (3).
99. Uniontown (6).

Franklin County:
100. Altenwald.
101. Beautiful.
102. Chambersburg (16).
103. Culbertson.
104. Edenville (7).
105. Greencastle.
106. Keefers (2).
107. Midvale.
108. Nova.
109. St. Thomas.
110. Springrun.
111. Waynesboro (7).

Fulton County:
112. Fort Littleton.

Greene County:
113. Waynesburg.

Huntingdon County:
114. Airydale (3).
115. Calvin.
116. Decorum.
117. Dublin Mills (near).
118. Entriken.
119. Lattagrove.
120. Maddensville.
121. Mapleton (mail Mapleton Depot).
122. Mill Creek.
123. Neelyton.
124. Orbisonia (2).
125. Saltillo (4).
126. Warrior Ridge (mail Petersburg).

Indiana County:
127. Clymer.
128. Covode.
129. Loop.
130. Northpoint (3).
131. Rochester Mills.

Jefferson County:
132. Brockwayville.
133. Munderf.
134. Punxsutawney.
135. Reynoldsville.
136. Sugar Hill.
137. Worthville (7).

Juniata County:
138. East Waterford.
139. McAlisterville.
140. Mexico.
141. Mifflintown.
142. Richfield (6).
143. Thompsontown.

Lackawanna County:
144. Scranton.

Lancaster County:
145. Bainbridge (2).
146. Bareville (3).
147. Churchtown.
148. Columbia.
149. East Earl.
150. East Petersburg.
151. Ephrata (6).
152. Gap.
153. Gordonville.
154. Lampeter.
155. Lancaster (5).
156. Lime Rock.
157. Manheim (4).
158. Marietta (2).
159. Marticville.
160. Mount Joy (4).
161. Quarryville.
162. Windom.

Lawrence County:
163. Plaingrove.
164. Volant.
165. Wampum (5).

Lebanon County:
166. Annville (8).
167. Cornwall.
168. East Hanover (5).
169. Kleinfeltersville.
170. Lebanon (11).
171. Myerstown.

Lehigh County:
172. Alburtis (4).
173. Allentown (5).
174. Emaus.
175. Sigmund.
176. South Whitehall (mail Walberts).

Lycoming County:
177. Collomsville.
178. Elimsport.
179. Hughesville (4).
180. Jersey Shore (2).
181. Montoursville (3).
182. Williamsport (5).

Mercer County:
183. Greenville.

Mifflin County:
184. Allensville (4).
185. Belleville (4).
186. Lewistown (4).
187. Mattawana.
188. Milroy (5).
189. Strodes Mills.

Directory of stone quarries in New York, New Jersey, and Pennsylvania—Con.

PENNSYLVANIA—Continued.

LIME AND LIMESTONE—continued.

Monroe County:
  190. Bossardsville.
  191. Kunkletown.
  192. Saylorsburg.
Montgomery County:
  193. Conshohocken.
  194. Norristown.
  195. Willow Grove (2).
Montour County:
  196. Danville (3).
  197. Limestoneville.
  198. Washingtonville (5).
Northampton County:
  199. Bethlehem (3).
  200. Easton (5).
  201. Hellertown (2).
  202. Nazareth (3).
  203. Northampton.
  204. Portland (2).
Northumberland County:
  205. Dalmatia (3).
  206. Herndon (3).
  207. Milton (7).
  208. Sunbury.
  209. Turbotville (2).
Perry County:
  210. Blain.
  211. Ickesburg.
  212. Loysville.
  213. Millerstown (3).
  214. New Bloomefild (5).
  215. Shermansdale.
Schuylkill County:
  216. Cressona.
  217. Sittler.
Snyder County:
  218. Fremont (mail Mount Pleasant Mills).
  219. Middle Creek.
Somerset County:
  220. Bakersville (2).
  221. Berlin (19).
  222. Elk Lick (3).
  223. Glessner.
  224. Hooversville.
  225. Meyersdale.
  226. Ralphton (2).
  227. Shanksville (3).
  228. Somerfield.
  229. Somerset (9).
  230. Stoyestown (6).
  231. Trent.
Susquehanna County:
  232. Montrose.
Union County:
  233. Allenwood.
  234. Lewisburg.
  235. Mifflinburg (9).
  236. Millmont.
Washington County:
  237. Washington (10).

PENNSYLVANIA—Continued.

LIME AND LIMESTONE—continued.

Westmoreland County:
  238. Alverton (5).
  239. Arona (3).
  240. Blairsville (near).
  241. Calumet.
  242. Claridge (3).
  243. Crisp.
  244. Fort Palmer.
  245. Goff (mail Crabtree).
  246. Greensburg (14).
  247. Irwin (9).
  248. Latrobe (9).
  249. Ligonier (6).
  250. Lycippus.
  251. Smithton (2).
York County:
  252. Dillsburg (3).
  253. Emigsville.
  254. Hellam (2).
  255. Thomasville.
  256. York (8).

SANDSTONE.

Allegheny County:
  1. Clairton.
  2. Epton.
  3. Fairhaven (2).
  4. McKeesport (3).
  5. North Braddock (2) (mail Braddock).
  6. Pittsburgh (11).
  7. Swissvale.
  8. Walkers Mills.
Armstrong County:
  9. Apollo.
  10. Lawsonham (near).
  11. Rimerton.
  12. Widnoon.
Beaver County:
  13. Beaver (2) and Monaca (2).
  14. Homewood.
  15. New Brighton.
  16. New Galilee.
  17. Parke Gate.
Bedford County:
  18. Hyndman (2).
Berks County:
  19. Birdsboro.
  20. Geigertown.
  21. Gouglersville and Mohnton.
Blair County:
  22. Altoona (2).
  23. Brookes Mills.
Bradford County:
  24. Wyalusing.
Bucks County:
  25. Grenoble.
  26. Lumberville.
  27. Milford Square.
  28. Newtown.

Directory of stone quarries in New York, New Jersey, and Pennsylvania—Con.

PENNSYLVANIA—Continued.

SANDSTONE—continued.

Bucks County—Continued.
  29. Point Pleasant.
  30. Quakertown.
  31. Yardley.
Butler County:
  32. Butler (5).
  33. Cabot.
  34. Sarver.
Cambria County:
  35. Dean.
  36. Johnstown (3).
  37. Patton.
Carbon County:
  38. Bowmanstown.
  39. Lehigh Tannery (2).
Chester County:
  40. Exton.
  41. Honeybrook.
  42. Planebrook.
  43. Pomeroy (2).
  44. Spring City.
  45. West Chester.
Clearfield County:
  46. Clearfield.
  47. Curwensville (3).
  48. Du Bois.
  49. Falls Creek.
  50. McGees Mills.
  51. Madera.
  52. Mahaffey.
  53. Wallaceton.
  54. West Decatur.
Clinton County:
  55. Aughanbaugh.
  56. Mill Hall.
Columbia County:
  57. Bloomsburg (2).
Crawford County:
  58. Meadville.
Delaware County:
  59. Ardmore (near).
  60. Media.
Dauphin County:
  61. Waltonville.
Elk County:
  62. Croyland.
  63. Daguscahonda.
  64. Glen Hazel.
  65. Instanter.
  66. Johnsonburg (2).
  67. Kersey.
  68. Ridgway (2).
Fayette County:
  69. Brownfield.
  70. Brownsville.
  71. Connellsville.
  72. Fairchance.
  73. Ferguson.
  74. Hopwood (4).
  75. Indian Creek.
  76. Layton.

PENNSYLVANIA—Continued.

SANDSTONE—continued.

Fayette County—Continued.
  77. McCune (mail Dickerson Run).
  78. Orient.
  79. Point Marion (3).
  80. Uniontown (3).
Greene County:
  81. Greensboro.
  82. Waynesburg (3).
Huntingdon County:
  83. Alexandria.
  84. Barree.
  85. Huntingdon (2).
  86. Mapleton Depot.
Indiana County:
  87. Blairsville.
  88. Indiana.
Jefferson County:
  89. Grove Summit.
  90. Punxsutawney (3).
Lackawanna County:
  91. Chinchilla.
  92. Nay Aug.
  93. Scranton (4).
Lancaster County:
  94. Elizabethtown (2).
Lawrence County:
  95. Ellwood City (5).
  96. Hillsville.
  97. New Castle.
  98. Rockpoint.
  99. Wampum (2).
Lebanon County:
  100. Mount Gretna.
Lehigh County:
  101. Allentown.
  102. Bethlehem.
Luzerne County:
  103. Hazleton.
  104. Shickshinny.
  105. Whitehaven (2).
  106. Wilkes Barre (2).
Lycoming County:
  107. Muncy.
  108. Picture Rocks.
  109. Williamsport (3).
McKean County:
  110. Smethport.
Mercer County:
  111. Greenville (5).
  112. Leesburg.
  113. Mercer.
  114. Sandy Lake.
  115. Sharon.
  116. Sharpsville.
  117. Volant (near).
Monroe County:
  118. Analomink.
Montgomery County:
  119. Ambler (2).
  120. Gladwyne.
  121. Hendricks.

Directory of stone quarries in New York, New Jersey, and Pennsylvania—Con.

PENNSYLVANIA—Continued.

SANDSTONE—continued.

Montgomery County—Continued.
122. Norristown (2).
123. Souderton.
124. Spring Mill.
Northumberland County:
125. Shamokin.
Potter County:
126. Galeton.
Somerset County:
127. Hooversville.
128. Milford Station (2).
129. Rockwood (3).
Susequehanna County:
130. Forest City.
Venango County:
131. Franklin (4).
132. Oil City (2).
133. Polk.
134. Rockmere.
Washington County:
135. Charleroi (2) and Twilight.
136. Washington (3).
Westmoreland County:
137. Adamsburg.
138. Armbrust.
139. Baggaley.
140. Bellevernon (near).
141. Bolivar.
142. Donohoe.
143. Export (4).
144. Greensburg (6).
145. Herminie.
146. Hunkers (3).
147. Irwin (5).
148. Latrobe (4).
149. Ligonier.
150. Welty.
151. West Newton.
152. Youngwood.

BLUESTONE.

Bradford County:
1. Canton.
2. Sugar Run.
3. Towanda (3).
4. Wyalusing.
Bucks County:
5. Perkasie.
Clinton County:
6. Farrandsville.
Fayette County:
7. Connellsville.
8. Upper Middletown and Waltersburg.
Greene County:
9. Waynesburg (2).
Lackawanna County:
10. Moscow.
Luzerne County:
11. Duryea.
Lycoming County:
12. Jersey Mills (6).

PENNSYLVANIA—Continued.

BLUESTONE—continued.

Lycoming County—Continued.
13. Trout Run (4).
14. Waterville (9).
15. Williamsport (2).
McKean County:
16. Port Allegany.
Pike County:
17. Dingmans Ferry.
18. Glen Eyre (2).
19. Kimble.
20. Lackawaxen (2).
21. Masthope (3).
22. Milford.
23. Pond Eddy.
24. Shohola (5).
25. Narrowsburg, N. Y. (near) (3).
26. Port Jervis, N. Y. (near) (3).
Potter County:
27. Burtville.
28. Oswayo.
Schuylkill County:
29. Tuscarora.
Susquehanna County:
30. Auburn Center.
31. Brooklyn.
32. Dimock (2).
33. Hallstead (4).
34. Lanesboro (8).
35. Lynn.
36. Montrose.
37. New Milford (3).
38. South Montrose.
39. Springville (3).
40. Stevens Point (4).
Wayne County:
41. Braman.
42. Equinunk (10).
43. Hawley (17).
44. Honesdale (2).
45. Kellam (2).
46. Shehawken (2).
47. Sherman (3).
48. Starlight (3).
49. White Mills.
50. Winterdale (3).
51. Winwood (2).
Westmoreland County:
52. Harrison City and Penns Station.
53. Hillside.
54. Ligonier (2).
Wyoming County:
55. Black Walnut.
56. Laceyville (11).
57. Lemon.
58. Mehoopany.
59. Meshoppen (5).
60. Mill City (2).
61. Nicholson (4).
62. Tunkhannock.
York County:
63. Hanover.

Directory of stone quarries in New York, New Jersey, and Pennsylvania—Con.

PENNSYLVANIA—Continued.

MARBLE.

Chester County:
  1. West Grove.
Luzerne County:
  2. Tannery (mail Lehigh Tannery).
Montgomery County:
  3. King of Prussia.
Northampton County:
  4. Easton (2).
York County:
  5. Delta.

SLATE.

Carbon County:
  1. Palmerton (2).
Dauphin County:
  2. Derry Church.
Lehigh County:
  3. Lynnport.
  4. Slatedale (10).
  5. Slatington (25).
  6. Wanamakers.
Northampton County:
  7. Bangor (17).
  8. Belfast (4).
  9. Chapman Quarries (4).
  10. Danielsville (9).
  11. Martins Creek Junction.
  12. North Bangor (2).
  13. Pen Argyl (17).
  14. Slateford.
York County:
  15. Delta (3).
  16. Peach Bottom (3).
  17. Stony Brook.
Lancaster County:
  18. Peters Creek.

GRANITE.

Berks County:
  1. Seisholtzville.
Bucks County:
  2. Langhorne (2).
  3. Neshaminy Falls and Trevose.
  4. Quakertown.
Chester County:
  5. St. Peter.
  6. West Chester (2).
  7. West Grove.
Delaware County:
  8. Ardmore (near) and Llanerch.
  9. Burmont, Clifton Heights (2), Darby, and Landsdowne.

PENNSYLVANIA—Continued.

GRANITE—continued.

Delaware County—Continued.
  10. Chester (3).
  11. Lima (2) and Media.
  12. Philadelphia (near).
  13. Trainer.
Lancaster County:
  14. Willow Street.
Lehigh County:
  15. Vera Cruz (3).
Montgomery County:
  16. Conshohocken (2) and West Conshohocken (2).
  17. Edge Hill, Glenside, and Ogontz.
  18. Sumneytown.

TRAP ROCK.

Adams County:
  1. Gettysburg.
Berks County:
  2. Birdsboro (3).
Bucks County:
  3. Bridge Valley.
  4. Cressman.
  5. Point Pleasant.
  6. Rock Hill.
  7. Rushland.
Chester County:
  9. Downingtown (3).
  10. Kennet Square.
  11. West Chester.
Dauphin County:
  12. Rockville.
Delaware County:
  13. Lenni Mills.
  14. Locksley.
  15. Radnor.
Luzerne County:
  17. Wapwallopen.
Montgomery County:
  18. Bethayres.
  19. Green Lane (3) and Perkiomenville.
  20. Pottstown (2).
  21. Sumneytown.
Northumberland County:
  22. Dalmatia.
Perry County:
  23. Marysville.
York County:
  24. Hanover.
  25. York Haven.

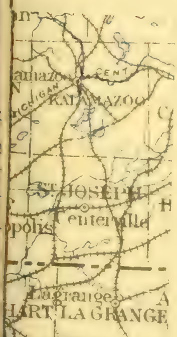
WISCONSIN AND MICHIGAN.

Although the larger part of the area of Wisconsin and Michigan is underlain by sedimentary rocks that yield limestone and sandstone suitable for quarrying, there is an important area of crystalline and metamorphic rocks occupying the greater part of north-central Wisconsin and northern Michigan in which quarries of granite and trap rock have been opened. (See Pl. V.)

A considerable portion of the area of Wisconsin and Michigan is thickly covered by glacial deposits of clay, gravel, and sand. Doubtless this cover retards the development of quarries to some extent, first by obscuring outcrops of good rock, and, second, by the expense which its removal entails in quarry operations.

Limestone.—Silurian rocks underlie the greater part of the eastern tier of counties in Wisconsin, and contain a thick formation of magnesian limestone. This rock is quarried in many places for stone to be burned into lime, and also to be crushed for concrete, macadam, and railroad ballast. The proximity of some of the quarries in eastern Wisconsin to water transportation on Lake Michigan has greatly aided their rapid development. Bordering the Silurian rocks on the west and extending across the southern tier of counties is a belt of rocks of Middle and Upper Ordovician age which also contain magnesian limestone. The limestone quarries west of Green Bay and west and south of Lake Winnebago, as well as in the southern counties, are in these rocks. Between the border of the Middle Ordovician area and the crystalline area of north-central Wisconsin is a wide belt of rocks of late Cambrian and early Ordovician age, consisting chiefly of sandstone and magnesian limestone. There are a few limestone quarries in these rocks, mainly near Mississippi River between Prairie du Chien and Hudson. The greater part of the lime made in Wisconsin is burned from Silurian magnesian limestone in the eastern part of the State, but there are a few small kilns burning lime for local use in the southern and western areas. One thin formation of relatively high-calcium Ordovician limestone is burned for lime in Lafayette County.

In Michigan Devonian formations, largely of limestone, border the northern part of the southern peninsula of the State along Lakes Michigan and Huron, and also cross the southeastern part of the State from Lake Huron to the Ohio line. A small area of Silurian limestone borders Lake Erie in the extreme southeast corner of the State, and at the extreme northern point of the southern peninsula there is also a narrow strip of Silurian rocks. Bordering the north end of Lake Michigan and the Straits of Mackinac are Silurian formations that constitute the country rock for some distance back from the shore in the northern peninsula. This is an extension of the belt of rocks that borders Lake Michigan in eastern Wisconsin. Adjoining the Silurian area on the west and north are rocks of Middle and Upper Ordovician age that enter the State from west of Green Bay, Wis., and succeeding these rocks toward the west and north are formations of late Cambrian and Ordovician age that form the shore line of Lake Superior east of Marquette and part of the shore line between Marquette and Keweenaw Point. The central area of the southern peninsula of Michigan is underlain by rocks of Carboniferous age, largely sandstone and shale. The limestone quarries in Michigan are therefore distributed mainly around the borders of the southern peninsula and near the shores of Green Bay and Lake Michigan in the northern peninsula, and are mainly in rocks of Ordovician, Silurian and Devonian age. There are certain noteworthy exceptions to this rule, however, in the case of quarries near Saginaw Bay and near where late Cambrian and early Ordovician rocks occur. The limestones of the Carboniferous and of the Devonian are high-calcium rocks; the lower limestones are generally high in magnesium.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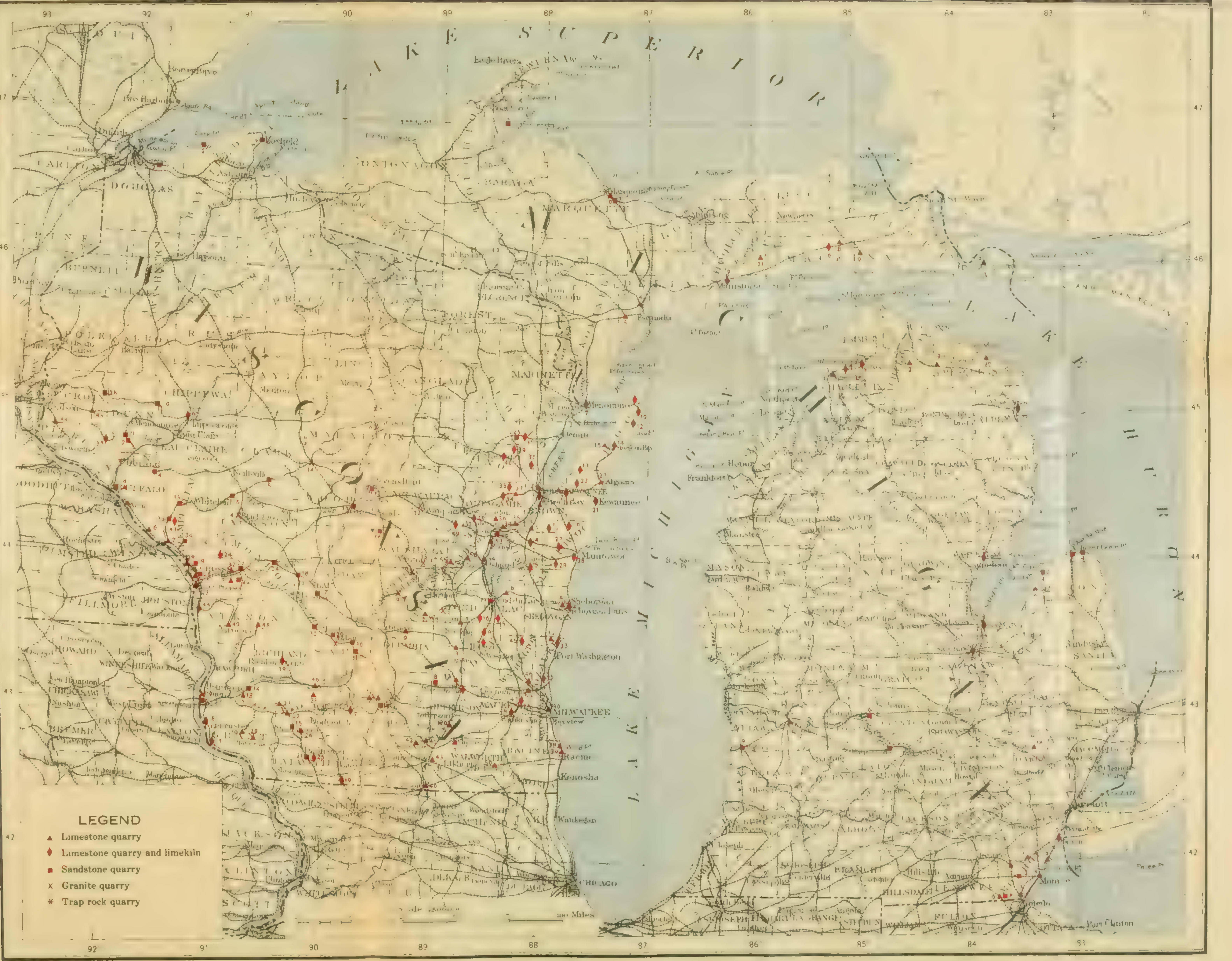

LAKE SUPERIOR
LAKE MICHIGAN
LAKE HURON
WISCONSIN
MICHIGAN
Duluth
Marquette
Menominee
Green Bay
Kewaunee
Algoma
Manitowoc
Sheboygan
Port Washington
Milwaukee
Racine
Kenosha
Waukegan
Chicago
Frankfort
Port Huron
Detroit
Toledo
Monroe
Port Clinton
100 Miles
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42
LEGEND
▲ Limestone quarry
♦ Limestone quarry and limekiln
■ Sandstone quarry
x Granite quarry
* Trap rock quarry

MAP OF WISCONSIN AND MICHIGAN

Showing location of limekilns and quarries of limestone, sandstone, granite, and trap rock

Prepared under the direction of E. F. Burchard

No account is taken in these quarry maps or descriptions of the marl deposits of Michigan or other States, for with the exception of its use as an ingredient in the manufacture of Portland cement, fresh-water marl can hardly be termed a quarry product.

Sandstone.—Sandstone formations occur in the rocks of Cambrian and Ordovician age in Wisconsin. Some of these sandstones are so loosely cemented and friable that the material is easily crushed and the product used for the various purposes for which sand is employed, including the manufacture of glass, but other beds are so firmly indurated as to become quartzite. Quartzitic sandstone, such as is quarried in Sauk County, Wis., is suitable for building stone, paving blocks, crushed stone, etc. A handsome, dark reddish-brown, medium-grained sandstone is quarried on the shore of Lake Superior, in Bayfield County, and the rock is shipped to many of the States in the Mississippi Valley, where it is used in the construction of large buildings. Sandstone quarries are reported in 24 counties of Wisconsin, mostly in the western half of the State.

The most valuable deposits of sandstone in Michigan are in the northern peninsula, along the shores of Lake Superior, in Houghton, Baraga, and Marquette counties. Two types of sandstone from northern Michigan have come to the attention of the writer. One, from near Marquette, is of a light brownish-red color, with spots showing on the surface similar to those made by raindrops. One trade name for this stone is consequently the "raindrop" sandstone. A uniformly colored red sandstone occurs in Houghton County, on Keweenaw Bay. These sandstones outcropping near Lake Superior are all of Cambrian age. Their development has been greatly facilitated by the advantages of water transportation.

In the southern peninsula of Michigan the Carboniferous rocks abound in sandstone beds, although in only a few places have materials of more than fair quality been found. Active quarries are operated in this portion of the State in Eaton, Huron, Ionia, Monroe, and Ottawa counties. The sandstone in Ionia County is fine to medium grained, rather soft sandstone. The color varies from white or light gray to buff and red. The rock is also mottled with pinkish to maroon streaks and patches, so that when sawed diagonally to the patches the blocks display an attractive mottled effect.

Granite.—The granite of this group of States is confined to north-central Wisconsin and parts of the northern peninsula of Michigan, but it is quarried commercially only in Wisconsin. Of late years Wisconsin has rapidly come forward as a producer of granite, since the area of this rock in this State is nearer Chicago than any other granite area, and that city consumes large quantities of this material in the form of paving blocks and as structural material. Granite is quarried in the following Wisconsin counties: Douglas, Green Lake, Jackson, Marathon, Marinette, Marquette, Sauk, Waupaca, Waushara, and Wood, but it underlies the whole or parts of at least 10 more counties. Many of the granites of Wisconsin are of reddish shades, some of them very dark, as in the case of certain granites from Marquette, Green Lake, and Waushara counties. Considerable granite from Green Lake and Marquette counties is used for monumental work. Gray granite is comparatively rare in Wisconsin. One sample, however, has come to the attention of the writer from Amberg, Marinette County. This sample was of a medium grain and the color was a medium shade of gray, but the deposit was reported to become darker in color with depth. The stone quarried in Waupaca County is a fine-grained pinkish-gray to pink granite. It is used for paving blocks and for crushed stone.

Trap rock.—The so-called trap rock quarried in this area is a greenstone schist, a metamorphic rock of Archean age that outcrops at Marquette, Mich. The entire output of several quarries is crushed and sold for concrete and roadmaking.

Directory.—The locations of the quarries of limestone, sandstone, granite, and trap rock, and of limekilns, in Wisconsin and Michigan, are given in the following directory:

Directory of stone quarries in Wisconsin and Michigan.

WISCONSIN.

LIMESTONE.

Brown County:
    1. Askeaton and Greenleaf.
    2. Bay Settlement (2).
    3. Depere (10).
    4. Duck Creek (3).
Buffalo County:
    5. Alma (2).
    6. Fountain City.
    7. Marshland.
    8. Nelson.
Columbia County:
    9. Pardeeville.
Crawford County:
    10. Prairie du Chien (3).
Dane County:
    11. Madison (3).
    12. Middletown.
Dodge County:
    13. Beaver Dam.
    14. Richwood and near Watertown (2).
Door County:
    15. Sevastopol (3) (mail Sturgeon Bay).
Fond du Lac County:
    16. Peebles.
    17. Waupun (2).
Grant County:
    18. Boscobel.
    19. Lancaster (2).
    20. Rockville.
Green Lake County:
    21. Markesan (2).
Iowa County:
    22. Cobb.
    23. Highland (2).
    24. Mineral Point.
    25. Wyoming.
Jefferson County:
    26. Fort Atkinson.
Kewaunee County:
    27. Algoma.
La Crosse County:
    28. Holmen (2).
    29. Onalaska (3).
Milwaukee County:
    30. Wauwatosa (5).

WISCONSIN—Continued.

LIMESTONE—continued.

Monroe County:
    31. Leon.
    32. Sparta (2).
Ozaukee County:
    33. Belgium.
Outagamie County:
    34. Appleton.
    35. Kaukauna (2).
    36. Mackville.
    37. Seymour.
Racine County:
    38. Ives.
    39. Racine.
Rock County:
    40. Beloit (6).
    41. Edgerton.
    42. Fulton.
    43. Janesville (2).
St. Croix County:
    44. River Falls (near).
    45. Woodville.
Sauk County:
    46. Spring Green (3).
Sheboygan County:
    47. Sheboygan Falls.
Vernon County:
    48. La Farge.
    49. Viroqua (2).
Walworth County:
    50. Springfield.
    51. Whitewater (2).
Waukesha County:
    52. Lannon (10) and Menominee Falls.
Winnebago County:
    53. Menasha and Neenah (4).
    54. Oshkosh (4).
    55. Poygan (2).
    56. Winneconne.

LIME AND LIMESTONE.

Brown County:
    1. Morrison.
    2. New Franken (3).
    3. Preble (2) (mail Green Bay).

Directory of stone quarries in Wisconsin and Michigan—Continued.

WISCONSIN—Continued.

LIME AND LIMESTONE—continued.

Calumet County:
- 4. Brillion.
- 5. Hayton.

Chippewa County:
- 6. Chippewa Falls.

Dane County:
- 7. Mount Horeb.

Dodge County:
- 8. Knowles (2).
- 9. Mayville (2).

Door County:
- 10. Baileys Harbor (2).
- 11. Fish Creek (2).
- 12. Jacksonport (2).
- 13. Namur (2).
- 14. Sawyer (4) and Sturgeon Bay (5).

Fond du Lac County:
- 15. Hamilton and Marblehead (3).
- 16. Oakfield (2).

Grant County:
- 17. Cassville.
- 18. Wyalusing.

Green County:
- 19. Martintown.

Jefferson County:
- 20. Watertown.

Kewaunee County:
- 21. Kewaunee.
- 22. Thiry Daems.

La Crosse County:
- 23. La Crosse (7).
- 24. Mindoro.

Lafayette County:
- 25. Darlington.

Manitowoc County:
- 26. Cooperstown (3).
- 27. Grimms.
- 28. Manitowoc.
- 29. Quarry and Valders (2).

Oconto County:
- 30. Chase.
- 31. Gillett.

Ozaukee County:
- 32. Cedarburg and Grafton (2).
- 33. Druecker.

Outagamie County:
- 34. Black Creek.
- 35. Cicero (2).
- 36. Hortonville.

Pierce County:
- 37. Elmwood (3).

Richland County:
- 38. Richland Center.

Shawano County:
- 39. Advance.
- 40. Bonduel.

Sheboygan County:
- 42. Sheboygan.

Trempealeau County:
- 43. Arcadia (5).

Vernon County:
- 44. Stoddard (6).

Washington County:
- 45. Kewaskum (2).
- 46. Rockfield and South Germantown (2).

Waukesha County:
- 47. Templeton.
- 48. Waukesha.

Waupaca County:
- 49. Readfield.

SANDSTONE.

Bayfield County:
- 1. Bayfield.
- 2. Port Wing.

Buffalo County:
- 3. Nelson (2).
- 4. Mondovi.

Clark County:
- 5. Neillsville.

Crawford County:
- 6. Prairie du Chien.

Dane County:
- 7. Madison (3).

Dodge County:
- 8. Waterloo (near).

Douglas County:
- 9. Wentworth.

Dunn County:
- 10. Colfax (2).
- 11. Downsville.
- 12. Dunnville.

Fond du Lac County:
- 13. Fond du Lac.

Grant County:
- 14. Boscobel.

Iowa County:
- 15. Linden.

Jackson County:
- 16. Alma Center (4).

Juneau County:
- 17. Mauston (3).
- 18. Orange (mail Camp Douglas).

La Crosse County:
- 19. Holmen.
- 20. Onalaska.

Lafayette County:
- 21. Darlington (2).

Monroe County:
- 22. Leon.
- 23. Sparta (21) and Lafayette.
- 24. Tomah.

Oconto County:
- 25. Gillett.

Outagamie County:
- 26. Appleton.

Portage County:
- 27. Stevens Point.

Directory of stone quarries in Wisconsin and Michigan—Continued.

WISCONSIN—Continued.

SANDSTONE—continued.

St. Croix County:
    28. Glenwood (2).
Sauk County:
    29. Ableman (5) and North Freedom.
    30. Baraboo (2).
    31. Devils Lake.
    32. Lavalle.
Trempealeau County:
    33. Arcadia (6).
    34. Galesville.
    35. Independence (4).
Waushara County:
    36. Plainfield.
Wood County:
    37. Grand Rapids (5).

GRANITE.

Douglas County:
    1. Superior.
Green Lake County:
    2. Berlin.
    3. Utley.
Jackson County:
    4. Black River Falls.
Marathon County:
    5. Granite Heights (4).
    6. Wausau.
Marinette County:
    7. Amberg (4).
    8. Middle Inlet.
Marquette County:
    9. Montello.
    10. Neshkora.
Sauk County:
    11. North Freedom.
Waupaca County:
    12. Granite City and Waupaca (3).
Waushara County:
    13. Lohrville (2), Red Granite (3), and Springlake (3).
Wood County:
    14. Marshfield.

MICHIGAN.

LIMESTONE.

Charlevoix County:
    1. Charlevoix.
Cheboygan County:
    2. Afton.
Chippewa County:
    3. Drummond.
Delta County:
    4. Groos (2).
    5. Hyde (2).
Huron County:
    6. Bayport.
Kent County:
    7. Grand Rapids.
Mackinac County:
    8. Fiborn Quarry.
    9. Ozark.

MICHIGAN—Continued.

LIMESTONE—continued.

Marquette County:
    10. Marquette.
Monroe County:
    11. Dundee.
    12. Ida (2).
    13. Maybee.
    14. Monroe (2).
    15. Newport (2).
    16. Ottawa Lake.
    17. Temperance.
Oakland County:
    18. Clarkston.
Presque Isle County:
    19. Onaway.
    20. Calcite.
Schoolcraft County:
    21. Blaney.

LIME AND LIMESTONE.

Alpena County:
    1. Alpena (3).
Arenac County:
    2. Omer (2).
Bay County:
    3. Bay City (2).
Charlevoix County:
    4. Bayshore.
Emmet County:
    5. Petoskey (3).
Mackinac County:
    6. Rexton.
Menominee County:
    7. Menominee (2).
Saginaw County:
    8. Saginaw.
Schoolcraft County:
    9. Manistique and Marblehead.
Wayne County:
    10. Trenton.

SANDSTONE.

Eaton County:
    1. Grand Ledge.
Houghton County:
    2. Jacobsville (2).
Huron County:
    3. Caseville.
    4. Grindstone.
    5. Port Austin (2).
Ionia County:
    6. Lyons.
Marquette County:
    7. Marquette.
Monroe County:
    8. Ottawa Lake.
Ottawa County:
    9. Holland.

TRAP ROCK.

Marquette County:
    1. Marquette (3).

ILLINOIS, INDIANA, OHIO, AND KENTUCKY.

The rocks exposed in this group of States (Pl. VI) are, with the exception of a very few thin dikes of intrusive rock in western Kentucky and southern Illinois, which do not affect this discussion, entirely of sedimentary material, for the most part in nearly horizontal beds. The only classes of rock to be considered are limestone and sandstone and certain cave deposits of small extent in Kentucky, the product of which is sold as onyx marble.

The central part of Illinois is so heavily drift laden that quarries can not generally be opened economically, and this condition applies also to much of the area of northern and central Indiana and to parts of Ohio.

Limestone.—In this group of States the principal limestone formations are of Ordovician, Silurian, Devonian, and Carboniferous age. Of the Carboniferous rocks the lowest or Mississippian series contains the most important limestone formations in the western part of the area. In Illinois the Ordovician formations in the north-central part, the Silurian in the Chicago area, and the Silurian and Devonian in the northwestern part of the State are all worked for limestone. Some high-calcium limestone is found in the Ordovician, but mainly the beds are magnesian. The Silurian limestones are also magnesian, but the Devonian limestone carries a high percentage of calcium carbonate. Along Mississippi River and the lower Illinois Valley practically all the limestone quarries are in Mississippian rocks, which are generally well exposed in the bluffs, and consequently economical quarrying sites are not difficult to find. Thus far development has taken place principally at points where railroads happen to be built near good limestone outcrops, although of course some quarries have been opened at a distance and connected with the main line by spur tracks. On Ohio River in southern Illinois Mississippian rocks are also quarried. In eastern Illinois a few quarries have been opened in Pennsylvanian limestone, notably a large fluxing stone quarry in Vermilion County. The Carboniferous rocks generally are fairly high in calcium and low in magnesium, but the Mississippian rocks particularly are apt to contain a considerable percentage of silica, in some places in the form of chert. Lime is made from all these limestones in Illinois.

Indiana is underlain by formations having the same range in age as those in Illinois. The Pennsylvanian rocks outcrop in western Indiana; Mississippian rocks are found in a belt a little west of the middle of the State and in an area in the extreme northeast corner; Devonian and Silurian formations underlie the northwestern, central, and northeastern portions, with Ordovician rocks in the southeast corner, which is affected by the Cincinnati anticline. The limestone quarries in Indiana are chiefly in the Mississippian, Devonian, and Silurian formations. Thirty-eight counties are reported as producers of limestone. Lawrence and Monroe counties are the principal producers of building stone in the State. The famous oolitic limestone quarried about Bedford as a center occurs in these counties in a favorable situation for quarrying. This limestone is of Mississippian age, and has but few counterparts in the United States so far as its physical characteristics are concerned. This Bedford stone is of medium fine-grained even texture, and is composed of small round concretionary grains and of broken fragments of fossils, all compactly cemented together by calcite. The stone occurs in masses 30 to 50 feet and even 70 feet thick. When fresh from the quarry the stone is soft and cuts easily, but after the "quarry water" has left the stone it becomes much harder. The color of the stone is a very attractive light gray, but it is easily affected by sulphurous and carbonic acid gases and darkens quickly in the presence of soot. The instability of color is due largely to the chemical activity of the stone, which is nearly pure calcium carbonate. On account of its evenness of grain and its softness when first quarried the stone is easily dressed and carved, and is very popular among builders for ornamental stone construction. The stone also possesses ample crushing strength for any use to which it may be put. A great industry has been built up in the district in which it is quarried in cutting stone according to specifications, and much special machinery has been designed for this purpose. On account of the purity of the stone considerable of the waste from the quarries is used for making lime and for blast-furnace flux, and a Portland cement mill was operated for several years using this stone in the manufacture of a high-grade product. Some of the most easily accessible stone has now been worked out, and in places, in addition to 5 feet of clay, thicknesses of as much as 35 feet of an overlying limestone have to be removed in order to reach the quarry stone. In addition to the counties mentioned, Owen, Crawford, Harrison, and Washington counties are said to be underlain by this oolitic limestone. In Bartholomew, Decatur, Jennings, and Ripley counties there is considerable quarrying in limestone of Devonian and Silurian age, and farther north, in Delaware, Grant, Wabash, and Huntington counties there are many quarries. This latter area is mainly in magnesian limestone of Silurian age. Some lime is burned from the Silurian limestone in Indiana, but the greater part of the output comes from the high-calcium Mississippian oolitic rock.

In Ohio the limestone quarries are chiefly in three areas which correspond to three geologic systems of rocks. In the northwestern and western part of the State the quarries are very largely in Silurian magnesian limestone; in southwestern Ohio near Cincinnati rocks of Ordovician age yield limestone low in magnesia but rather high in silica, or in silica and alumina; in eastern Ohio—in Carroll, Stark, Tuscarawas, and other counties—Pennsylvanian limestones are quarried. These latter rocks are high in calcium carbonate. Lime is burned principally from the magnesian Silurian limestone and from the high-calcium Pennsylvanian beds.

Kentucky is underlain by the same geologic formations that have been mentioned above in Illinois, Indiana, and Ohio. In fact, these four States are more closely associated geologically than any other group of the United States having an equal area. Kentucky has a less area, however, of Silurian rocks, these formations being confined to a narrow strip in central Kentucky around the border of Ordovician rocks that form the Cincinnati anticline. The formations that yield the greater part of the limestone quarried in Kentucky are of Ordovician and Mississippian age. The first-mentioned system is represented in the central part of the State southward from Cincinnati, Ohio, and quarries in it are operated in Harrison, Bourbon, Scott, Franklin, Anderson, Fayette, Jessamine, Mercer, Boyle, and other counties. A

London
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PULASKI
LAUREL
Manchester
Somerset
Barbourville
Monticello
KNOX
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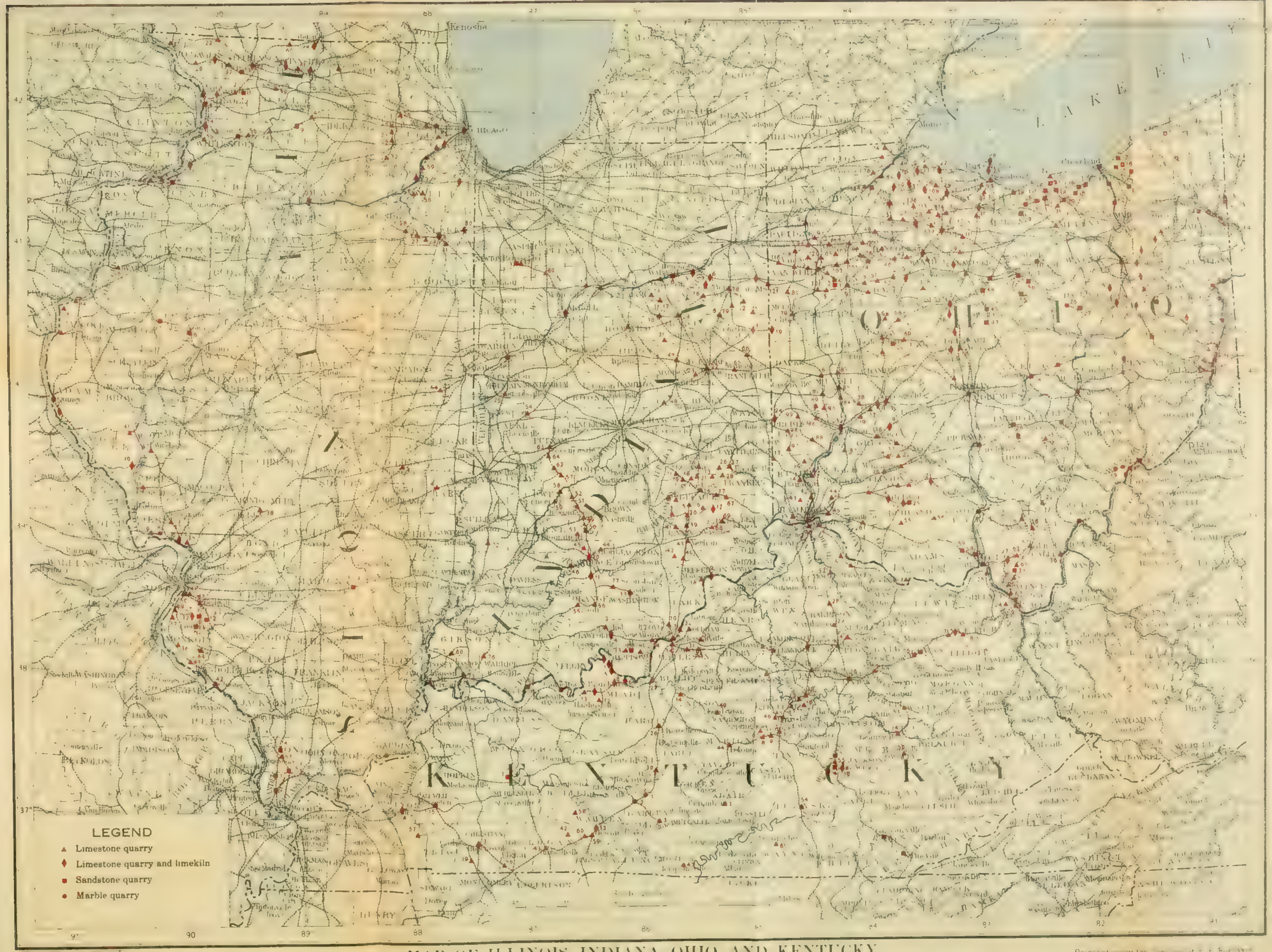
WAYNE
Williamsburg
Pine
WHITLEY
100 Miles
CLAIBORNE
CAMPBELL
Tazewell
Jacksboro
UNION
35°
84

D KENTUCKY

andstone, and marble

U. S. GEOLOGICAL SURVEY
GEORGE OTIS SMITH, DIRECTOR

MINERAL RESOURCES, [illegible] PART [illegible] PLATE V


Kenosha
Chicago
LAKE ERIE
ILLINOIS
INDIANA
OHIO
KENTUCKY
LEGEND
▲ Limestone quarry
♦ Limestone quarry and limekiln
■ Sandstone quarry
● Marble quarry
90
89
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MAP OF ILLINOIS, INDIANA, OHIO, AND KENTUCKY
Showing location of limekilns and quarries of limestone, sandstone, and marble

Prepared [illegible]

small quantity of lime is burned in this area. Limestone quarries in Mississippian rocks are scattered pretty well through the southern part of the State, but the most important area is near Bowling Green, Warren County. An oolitic limestone outcrops here, very similar in physical characteristics and of nearly equivalent age to the stone described above occurring in the Bedford (Ind.) district. This oolitic limestone is in a massive, homogeneous stratum, 22 feet thick. It is quarried and dressed on a large scale, and its production represents a large and growing industry. Other areas of oolitic stone occur near Somerset, Pulaski County, and in Barren, Simpson, Logan, Meade, Hardin, Grayson, Caldwell, Todd, Christian, Wolfe, Powell, and Rockcastle counties and is quarried in a few of them. This oolitic stone has a high content of calcium carbonate and is burned for lime at Bowling Green and several other places.

Sandstone.—The most important areas of quarriable sandstone in this group of States are in Ohio and Kentucky, and these resources will be discussed more fully later.

In Illinois there are 10 counties from which the production of sandstone is reported. A few of these quarries are in Ordovician beds in the northern part of the State, but the majority are around the border of the Pennsylvanian formations, or "Coal Measures," in the western and southern parts of the State. It is possible that at the extreme southern end of the State near Cairo the Cretaceous deposits may contain some sandstone sufficiently indurated for quarrying. It can be said, however, that Illinois is not well supplied with a very good grade of sandstone for building or crushed stone. The great deposits of Ordovician sandstone in Illinois and Fox River valleys are so friable that the material is produced principally as a glass sand; consequently those developments are not included in this discussion.

In quality of sandstone deposits Indiana fares no better than Illinois. There are a few quarries worked for material for local structural or road use in the Pennsylvanian area in western and southern Indiana, and also a very few quarries each in Mississippian and Silurian rocks in the southern and northeastern parts of the State, respectively.

With the exception of a few quarries in the Silurian area of the western part of the State the important sandstone quarries of Ohio are in Mississippian and Pennsylvanian formations in the east half of the State, and of these two series the Mississippian yields the greater quantity of sandstone. The great quarry formation of this series is the Berea sandstone. It extends in northern Ohio from Ashtabula County westward into Erie County, and thence nearly southward in a belt across the State to Ohio River. Where quarried most extensively at present, in Cuyahoga and Lorain counties, the rock is a fine-grained, homogeneous, evenly bedded sandstone of a light-buff, gray, or blue-gray color. The individual layers vary from a few inches to 10 or more feet in thickness, and the planes of separation are extremely smooth and straight. The stone contains about 95 per cent of silica, with small percentages of iron and aluminum oxides, lime, magnesia, and alkalies. There is very little cementing material between the grains, but there is considerable cohesion, induced probably by pressure. The stone is not hard enough, however, to be employed to an important extent for paving, but the greatest output is in the form of dressed building blocks. The Berea stone is also largely made into grindstones, for which purpose it is reported to be excellently suited, chiefly because it does not possess a cementing material. The presence of cementing material causes a grindstone to become glazed and its abrasive power is thereby destroyed. A blue-gray sandstone is obtained from an adjacent Mississippian formation in Cuyahoga County. Both these sandstones unfortunately contain in places pyrite specks, which cause discolorations. They are capable of receiving sharp lines when carved, but in time spalling often obliterates carved work, especially in damp climates subject to sudden and great extremes in temperature. There are many other quarry areas scattered about eastern Ohio, among which may be mentioned that of Washington County, where fine-grained, buff, and blue-gray sandstone of Permian age is extensively quarried for sandstone for building and for grindstones.

Sandstone is quarried in four widely separated areas in Kentucky. One is in Rowan County, the second is in Rockcastle County, the third is in Bell and Knox counties, and the fourth is in Muhlenberg County. The Rowan County stone is a fine-grained, light gray sandstone probably of Mississippian age. The sandstone in Rockcastle County is of probably Mississippian age, and that of Knox County is of Pennsylvanian age, as is that of Muhlenberg County.

Marble.—True marble does not occur anywhere in this group of States. In the mountainous regions of eastern Kentucky there may be beds of limestone sufficiently crystalline in places to take a good polish, but as yet none have been noted by the Survey. The marble included here and indicated as being quarried in Barren County, Ky., is a cave deposit of calcium carbonate known as onyx marble. These deposits occur in caves in limestones, and are formed by deposition from solution in waters that have percolated through the surrounding limestone into the cave, and through release of pressure, evaporation, etc., have deposited the mineral matter held in solution. The formation of sheets of onyx marble on the ceiling or walls of a cave is analagous to the deposition of calcium carbonate to form stalactites and stalagmites in caves.

Some very beautiful effects are produced by cutting and polishing pieces of onyx marble so as to bring out the banding or other figures, and the material is in demand for decorative and ornamental purposes. This material is reported to be present in the limestone regions of Indiana and Tennessee as well as in Kentucky.

Directory.—The locations of quarries in this group of States are given in the following directory:

Directory of stone quarries in Illinois, Indiana, Ohio, and Kentucky.

ILLINOIS.

LIMESTONE.

Boone County:
  1. Belvidere (3).
Carroll County:
  2. Lanark.
  3. Mount Carroll.
Clark County:
  4. Martinsville.
Coles County:
  5 Charleston.

ILLINOIS—Continued.

LIMESTONE—continued.

Cook County:
  6. Gary.
  7. Hillside.
  8. Lagrange.
  9. Lemont (3).
Dupage County:
  10. Elmhurst.
Greene County:
  11. Eldred.

Directory of stone quarries in Illinois, Indiana, Ohio, and Kentucky—Continued.

ILLINOIS—Continued.

LIMESTONE—continued.

Hancock County:
12. Hamilton.
13. Nauvoo.
14. Niota.

Harden County:
15. Elizabethtown.

Henderson County:
16. Biggsville.

Jersey County:
17. Delhi.
18. Elsah.
19. Grafton (2).

Jo Daviess County:
20. Elizabeth.
21. Galena.
22. Warren.

Kane County:
23. Batavia (2).
24. Geneva.
25. North Aurora.
26. South Elgin.

Kankakee County:
27. Bonfield.
28. Essex.
29. Lehigh.
30. Momence.
31. Waldron (2).

Kendall County:
32. Oswego.

La Salle County:
33. La Salle.

Lee County:
34. Dixon (6).

Madison County:
35. Upper Alton (2).

Monroe County:
36. Maeystown.
37. New Hanover.

Montgomery County:
38. Hillsboro.

gle County:
39. Leaf River.
40. Rochelle (3).

ike County:
41. Valley City.

andolph County:
42. Chester.
43. Prairie du Rocher.
44. Red Bud (2).

ock Island County:
45. Moline (2).
46. Rock Island.

t. Clair County:
47. Belleville.
48. Centerville Station.
49. Columbia.
50. East Carondelet (2).

cott County:
51. Alsey.

ephenson County:
52. Kent.

nion County:
53. Anna.

ILLINOIS—Continued.

LIMESTONE—continued.

Vermilion County:
54. Fairmount.

Whiteside County:
55. Garden Plain.
56. Rockfalls and Sterling.

Will County:
57. Elwood (2).
58. Manhattan.
59. Romeoville (mail Lockport).

Winnebago County:
60. Durand.
61. Winnebago.

LIME AND LIMESTONE.

Adams County:
1. Marblehead.
2. Quincy (5) (3 lime).

Carroll County:
3. Savanna (2).

Cook County:
4. Chicago (3) (lime) +1 quarry.
5. Hawthorne, Lyons (2) (1 lime), and Summit (4).
6. Thornton.

Jo Daviess County:
7. Stockton.

Kankakee County:
8. Kankakee (4) (1 lime).

Madison County:
9. Alton (12) (1 lime).

Pike County:
10. Pearl (2) (1 lime).

Rock Island County:
11. Port Byron.

St. Clair County:
12. Millstadt.

Stephenson County:
13. Freeport.

Whiteside County:
14. Fulton (4).

Will County:
15. Joliet (12) (1 lime).

Winnebago County:
16. Pecatonica.
17. Rockford.
18. Rockton.

SANDSTONE.

Alexander County:
1. Elco.
2. Tamms.

Carroll County:
3. Lanark.
4. Savanna (2).

Clay County:
5. Xenia.

Fulton County:
6. Lewistown.
7. Marietta.

Henry County:
8. Colona.

Lee County:
9. Ashton.

Directory of stone quarries in Illinois, Indiana, Ohio, and Kentucky—Continued.

ILLINOIS—Continued.

SANDSTONE—continued.

St. Clair County:
- 10. Millstadt.
- 11. Paderborn.
- 12. Smithton (3).

Stephenson County:
- 13. Pearl City.

Union County:
- 14. Anna.
- 15. Dongola.

Whiteside County:
- 16. Rockfalls.

INDIANA.

LIMESTONE.

Adams County:
- 1. Geneva (3).
- 2. Linngrove (2).

Bartholomew County:
- 3. Burnsville.
- 4. Hartsville (3).
- 5. Hope.

Blackford County:
- 6. Montpelier.

Cass County:
- 7. Kenneth and Trimmer.
- 8. Logansport.

Clark County:
- 9. Jeffersonville.
- 10. Sellersburg.
- 11. Utica.

Crawford County:
- 12. Marengo.

Decatur County:
- 13. Clarksburg (3).
- 14. Greensburg (3).
- 15. Letts (2).
- 16. Millhousen.
- 17. New Point.
- 18. St. Omer.
- 19. St. Paul (5).
- 20. Westport (3).
- 21. Williamstown.

Delaware County:
- 22. Muncie (3).
- 23. Yorktown.

Floyd County:
- 24. Edwardsville.

Fountain County:
- 25. Yeddo.

Franklin County:
- 26. Andersonville (2).
- 27. Laurel (3).
- 28. Stips Hill.

Grant County:
- 29. Marion (4).
- 30. Mier.
- 31. Rigdon.
- 32. Somerset (near).

Harrison County:
- 33. Corydon.
- 34. Kings Cave.

INDIANA—Continued.

LIMESTONE—continued.

Howard County:
- 35. Kokomo (3).

Huntington County:
- 36. Warren (2).

Jasper County:
- 37. Rensselaer.

Jefferson County:
- 38. Hanover (2).

Jennings County:
- 39. Brewersville.
- 40. Commiskey.
- 41. Scipio (2).
- 42. Slate.
- 43. Vernon (2) and North Vernon.

Lawrence County:
- 44. Heltonville.
- 45. Oolitic (2) and Peerless.
- 46. Williams.

Madison County:
- 47. Alexandria (4).
- 48. Ingalls.

Monroe County:
- 49. Bloomington (22).
- 50. Clear Creek (5) and Sanders (2).
- 51. Ellettsville (2).
- 52. Stinesville (5).
- 53. Victor.

Montgomery County:
- 54. Waveland.

Orange County:
- 55. French Lick.
- 56. Paoli.

Owen County:
- 57. Quincy (2).
- 58. Romona (2).
- 59. Spencer.

Posey County:
- 60. Cynthiana.
- 61. Mount Vernon.

Putnam County:
- 62. Cloverdale (3).
- 63. Greencastle (7).
- 64. Putnamville.

Randolph County:
- 65. Farmland.
- 66. Ridgeville.

Ripley County:
- 67. Batesville.
- 68. Holton.
- 69. Osgood (3).

Rush County:
- 70. Milroy (2).

Shelby County:
- 71. Waldron.

Sullivan County:
- 72. Carlisle.

Vanderburg County:
- 73. Evansville (6) and Howell.

Wabash County:
- 74. Red Bridge.
- 75. Wabash (4).

Directory of stone quarries in Illinois, Indiana, Ohio, and Kentucky—Continued.

INDIANA—Continued.

LIMESTONE—continued.

Warrick County:
    76. Elberfeld.
Washington County:
    77. Campbellsburg.
Wells County:
    78. Bluffton.
    79. Petroleum.
White County:
    80. Monon.

LIME AND LIMESTONE.

Adams County:
    1. Decatur (3).
Carroll County:
    2. Delphi (3).
Crawford County:
    3. Cape Sandy and Schooner Point.
    4. Milltown (2).
Huntington County:
    5. Huntington (3).
    6. Markle.
    7. Rockcreek.
Jay County:
    8. Portland.
Jefferson County:
    9. Madison.
Lawrance County:
    10. Bedford (17).
    11. Mitchell.
Ripley County:
    12. Napoleon (3).
Washington County:
    13. Salem.

SANDSTONE.

Fountain County:
    1. Attica.
Harrison County:
    2. Corydon.
Jasper County:
    3. Rensselaer.
Perry County:
    4. Cannelton.
Spencer County:
    5. Grandview.
Wabash County:
    6. Lagro.

OHIO.

LIMESTONE.

Adams County:
    1. Manchester (2).
Allen County:
    2. Allentown.
    3. Auglaize.
    4. Bluffton (3).
    5. Conant.
    6. Delphos.
    7. Harrod.
    8. Lafayette.
    9. Lima (6).
    10. Spencerville.

OHIO—Continued.

LIMESTONE—continued.

Belmont County:
    11. Bellaire.
    12. Martins Ferry.
Butler County:
    13. College Corner (6).
    14. Hamilton (7).
    15. Jacksonboro.
    16. Woodsdale.
Clark County:
    17. Enon.
    18. New Carlisle.
    19. Osborn (near).
Clermont County:
    20. Williamsburg (3).
Clinton County:
    21. Blanchester.
    22. Bloomington.
    23. New Vienna.
    24. Port William.
    25. Reesville.
    26. Wilmington (5).
Columbiana County:
    27. East Liverpool.
Crawford County:
    28. Bucyrus.
    29. Lykens.
Delaware County:
    30. Delaware.
Erie County:
    31. Castalia.
    32. Sandhill (4).
    33. Sandusky (3).
Franklin County:
    34. Columbus (4).
    35. Dublin.
Gallia County:
    36. Gallipolis.
Greene County:
    37. Jamestown.
    38. Xenia.
Guernsey County:
    39. Cambridge.

Hamilton County:
    40. Bridgetown.
    41. Cincinnati (4).
    42. Glendale.
    43. Mount Healthy.
    44. Symmes.
    45. Terrace Park.

Hancock County:
    46. Arlington (2).
    47. Findlay (4).
    48. McComb.
    49. Mount Blanchard.
    50. Rawson.

Hardin County:
    51. Ada.
    52. Dunkirk.

Highland County:
    53. Highland.
    54. Sinking Spring.
    55. Sugar Tree Ridge.

Directory of stone quarries in Illinois, Indiana, Ohio, and Kentucky—Continued.

OHIO—Continued.

LIMESTONE—continued.

Jackson County:
- 56. Jackson.
- 57. Kitchen Station.
- 58. Rocky Hill.

Jefferson County:
- 59. Rayland.
- 60. Tiltonsville.

Lawrence County:
- 61. Campbell.
- 62. Culbertson.
- 63. Eifort.
- 64. Ironton (4).
- 65. Olive Furnace.

Logan County:
- 66. Belle Center.
- 67. Bellefontaine.
- 68. Big Springs (2).
- 69. East Liberty.
- 70. West Liberty.

Lorain County:
- 71. Lagrange.
- 72. Lorain.

Lucas County:
- 73. Holland.
- 74. Sylvania (2).
- 75. Waterville.
- 76. Whitehouse.

Mahoning County:
- 77. Lowellville.

Medina County:
- 78. Spencer.

Mercer County:
- 79. Celina.
- 80. Rockford.

Miami County:
- 81. Covington (3).
- 82. Ludlow Falls.
- 83. Piqua (3).
- 84. Tippecanoe.
- 85. Troy.

Montgomery County:
- 86. Brookville.
- 87. Centerville.
- 88. Farmersville.
- 89. Phillipsburg.
- 90. Union (2).

Ottawa County:
- 91. Clay Center.

Paulding County:
- 92. Junction.
- 93. Oakwood.
- 94. Roselms.

Perry County:
- 95. Maxville.

Portage County:
- 96. Atwater.

Preble County:
- 97. Camden (5).
- 98. Eaton (4).
- 99. Lewisburg (2).

Putnam County:
- 100. Cascade and Cloverdale.
- 101. Columbus Grove.
- 102. Gilboa.
- 103. Kalida.
- 104. Ottawa.
- 105. Ottoville.
- 106. Pandora.
- 107. Vaughnsville.

Sandusky County:
- 108. Lindsey.

Seneca County:
- 109. Bascom.
- 110. Bettsville (2).
- 111. Bloomville (4).
- 112. Flat Rock (2).
- 113. Kansas.
- 114. Maple Grove (2).

Tuscarawas County:
- 115. Mineral City.

Van Wert County:
- 116. Convoy.
- 117. Middlepoint.
- 118. Scott.
- 119. Van Wert.
- 120. Wetzel.
- 121. Willshire.

Vinton County:
- 122. Oreton.

Wood County:
- 123. Bloomdale.
- 124. Grand Rapids.
- 125. North Baltimore.
- 126. Rising Sun.

Wyandot County:
- 127. Crawford.
- 128. Marseilles.

LIME AND LIMESTONE.

Belmont County:
- 1. Bridgeport.
- 2. West Wheeling.

Clark County:
- 3. Cold Springs (2).
- 4. Springfield (7).

Crawford County:
- 5. Oceola (2).

Delaware County:
- 6. Radnor (2).
- 7. White Sulphur.

Erie County:
- 8. Kelleys Island.

Greene County:
- 9. Cedarville (2).

Hardin County:
- 10. Patterson.

Harrison County:
- 11. Germano.

Highland County:
- 12. Greenfield (2).
- 13. Hillsboro (5).
- 14. Lynchburg (3).

Holmes County:
- 15. Winesburg.

Directory of stone quarries in Illinois, Indiana, Ohio, and Kentucky—Continued.

OHIO—Continued.

LIME AND LIMESTONE—continued.

Huron County:
16. Bellevue (4).
Marion County:
17. Marion (5).
18. Owens.
Mercer County:
19. Fort Recovery.
Montgomery County:
20. Dayton (8).
Ottawa County:
21. Genoa (2).
22. Limestone and Rockyridge (4).
23. Marblehead (2).
Preble County:
24. New Paris (3).
Sandusky County:
25. Fremont (6).
26. Gibsonburg (2).
Scioto County:
27. South Webster.
Seneca County:
28. Fostoria (2).
29. Tiffin (4).
Stark County:
30. Canton.
31. Howenstine.
32. Marlboro.
33. Middlebranch.
Tuscarawas County:
34. New Philadelphia
35. Sugar Creek.
Wood County:
36. Lime City.
37. Luckey (2).
38. Portage (3).
39. Sugar Ridge (2).
Wyandot County:
40. Carey.

SANDSTONE.

llen County:
1. Allentown.
shland County:
2. Ashland.
shtabula County:
3. Windsor Mills (2).
elmont County:
4. Bellaire.
5. McClainville.
6. Martins Ferry.
arroll County:
7. Sherodsville.
olumbiana County:
8. East Liverpool (2).
9. Wellsville.
rawford County:
10. Crestline.
yahoga County:
11. Berea (2).
12. Bluestone (3).
13. Chagrin Falls (4).
14. Cleveland.
15. Independence.

OHIO—Continued.

SANDSTONE—continued.

Cuyahoga County—Continued.
16. South Euclid.
17. Warrensville.
18. West View.
Erie County:
19. Berlin Heights.
Fairfield County:
20. Lancaster (3).
21. Sugar Grove.
Geauga County:
22. Thompson.
Guernsey County:
23. Tyner.
Harrison County:
24. Tippecanoe (2).
Highland County:
25. Hillsboro (2).
Holmes County:
26. Glenmont.
27. Killbuck (2)
Huron County:
28. Wakeman.
29. West Clarksfield.
Jefferson County:
30. Empire.
31. Steubenville (2).
Lawrence County:
32. Coal Grove (3) and Forestdale (2).
33. Olive Furnace.
Licking County:
34. Newark.
Logan County:
35. Pickrelltown.
Lorain County:
36. Amherst (2).
37. Columbia Station.
38. Elyria.
39. Grafton.
40. Kipton.
41. North Amherst.
42. Oberlin.
Mahoning County:
43. Brier Hill.
44. Haselton.
45. Youngstown (5).
Meigs County:
46. Pomeroy.
Morrow County:
47. Fulton.
48. Iberia.
49. Mount Gilead.
Muskingum County:
50. Blackrun.
51. Zanesville (4).
Perry County:
52. New Lexington.
Pickaway County:
53. Circleville (2).
Pike County:
54. Waverly.
Richland County:
55. Bellville.

Directory of stone quarries in Illinois, Indiana, Ohio, and Kentucky—Continued.

OHIO—Continued.

SANDSTONE—continued.

Richland County—Continued.
  56. Lucas.
  57. Mansfield.
Scioto County:
  58. Freestone and McDermott.
  59. Otway.
  60. Portsmouth (2).
Stark County:
  61. Massillon (3).
Summit County:
  62. Peninsula.
  63. Twinsburg.
Trumbull County:
  64. Mineral Ridge.
Washington County:
  65. Briggs.
  66. Constitution (2).
  67. Fleming.
  68. Marietta (3)
  69. Vincent.
Wood County:
  70. Grand Rapids.

KENTUCKY.

LIMESTONE.

Adair County:
  1. Columbia.
Anderson County:
  2. Lawrenceburg.
Barren County:
  3. Glasgow.
Bourbon County.
  4. Millersburg (2).
  5. Paris.
Boyd County:
  6. Ashland.
Boyle County:
  7. Danville (2).
  8. Mitchellsburg.
  9. Parkville.
  10. Perryville (3).
Bracken County:
  11. Bradford.
Breckinridge County:
  12. Basin Spring.
  13. Mystic
Bullitt County:
  14. Clermont.
Caldwell County:
  15. Princeton.
Campbell County:
  16. Fort Thomas (2) and Newport (3).
Carter County:
  17. Lawton (2).
  18. Olive Hill (2).
Christian County:
  19. Herndon.
Clark County:
  20. Winchester.

KENTUCKY—Continued.

LIMESTONE—continued.

Fayette County:
  21. Lexington (11).
Franklin County:
  22. Benson.
  23. Frankfort.
Greenup County:
  24. Amanda (mail Russell).
  25. Limeville.
Hardin County:
  26. Elizabethtown.
  27. West Point.
Harrison County:
  28. Berry.
  29. Cynthiana (2).
Hart County:
  30. Dividing Ridge.
Jefferson County:
  31. Buechel.
  32. Florida Heights (mail Prospect).
  33. Jeffersontown (3).
  34. Louisville (12).
  35. O'Bannon.
Jessamine County:
  36. Hanly.
  37. Highbridge.
  38. Nicholasville (4).
  39. Wilmore.
Kenton County:
  40. Covington (7) and Latonia.
Lee County:
  41. Beattyville.
Logan County:
  42. Gasper.
  43. Russellville (2).
Marion County:
  44. Lebanon.
Mercer County:
  45. Burgin.
  46. Harrodsburg.
Monroe County:
  47. Tompkinsville.
Montgomery County:
  48. Mount Sterling (3).
Nelson County:
  49. Woodlawn.
Owsley County:
  50. Booneville.
Pendleton County:
  51. Carntown and Ivor (2).
  52. Menzies.
Powell County:
  53. McCormick.
Pulaski County:
  54. Somerset (7).
Rockcastle County:
  55. Dudley.
Todd County:
  56. Trenton.
Trigg County:
  57. Hematite.

Directory of stone quarries in Illinois, Indiana, Ohio, and Kentucky—Continued.

KENTUCKY—Continued.

LIMESTONE—continued.

- Warren County:
  - 58. Hadley.
  - 59. Memphis Junction (4).
  - 60. Rockfield.
- Wayne County:
  - 61. Monticello.

LIME AND LIMESTONE.

- Breckinridge County:
  - 1. Webster.
- Carter County:
  - 2. Limestone.
- Christian County:
  - 3. Hopkinsville.
- Lyon County:
  - 4. Kuttawa.
- Meade County:
  - 5. Battletown (4).
  - 6. Brandenburg.
  - 7. Cedar Branch (2).
  - 8. Sirocco.
- Rockcastle County:
  - 9. Mount Vernon (2).
  - 10. Withers.

KENTUCKY—Continued.

LIME AND LIMESTONE—continued.

- Scott County:
  - 11. Georgetown.
- Warren County:
  - 12. Bowling Green (7).

SANDSTONE.

- Bell County:
  - 1. Pineville (2).
- Knox County:
  - 2. Barbourville (5).
- Muhlenburg County:
  - 3. South Carrollton.
- Rockcastle County:
  - 4. Langford.
  - 5. Wildie.
- Rowan County:
  - 6. Farmers.
  - 7. Freestone (2).

MARBLE.

- Barren County:
  - 1. Cave City (2).
  - 2. Glasgow Junction (2).

MARYLAND, DELAWARE, VIRGINIA, WEST VIRGINIA, NORTH CAROLINA, AND SOUTH CAROLINA.

This group of States (Pl. VII) is well supplied with quarry material. Limestone, sandstone, marble, slate, and granite are quarried, and lime is burned at many points.

Limestone, lime, and marble.—The limestones of this area fall physically into three groups: (1) The nonmetamorphosed limestones of the Appalachian valleys; (2) the metamorphosed or crystalline limestones of the Piedmont region, both of which are hard limestone; (3) and the soft limestone of the Coastal Plain. The great limestone deposits of the Valley of Virginia are the most noteworthy in this area. They are easily accessible, and consequently are extensively utilized. These same limestone belts extend from northern Virginia across the corner of West Virginia and through Maryland into Pennsylvania. West of the Alleghanies there are hard limestone deposits in eastern West Virginia, but only in the northern part of the State are they extensively utilized for the production of stone and lime. Southwestward they extend into Tennessee. Limestone is not abundant in the Piedmont region, except where it has been altered to marble, but it is quarried in a few places, notably in Henderson, Transylvania, and Yadkin counties, N. C.; Cherokee County, S. C.; Loudoun County, Va.; and Frederick and Carroll counties, Md. The hard limestones may be either high-calcium or magnesian rocks. The soft limestones of the Coastal Plain consist largely of shell marl, nd important quarries are situated in Norfolk County, Va.; Craven and Jones counties, N. C.; and Charleston County, S. C. The shell imestones are generally quite pure and contain little magnesia, but hey contain considerable silica in places, due to the admixture of and.

The marble deposits are mainly east of the Appalachian axis, either in the mountainous country or on the Piedmont Plateau. In some cases crystalline limestone occurs among the rocks in the Great Valley which have suffered little or no metamorphism, and although some beds may not be true marbles, according to the strictest definition, they are, nevertheless, commercially to be regarded as marbles, and are indicated as marble on the maps herewith. The principal development of marble quarries in this area is in Baltimore, Carroll, Harford, and Washington counties, Md.; and there are also quarries in Albemarle and Botetourt counties, Va.; in Graham and Cherokee counties, N. C.; and in Oconee County, S. C.

Sandstone.—The sandstones in this area are mostly in the coal fields of West Virginia and are of Carboniferous and Devonian age, although there are important deposits in the Triassic areas of the Piedmont region of Maryland, Virginia, and North Carolina, as well as in western and northern Maryland.

Slate.—Slate occurs in the Piedmont region and is quarried in Frederick and Harford counties, Md.; in Albemarle, Amherst, Buckingham, and Fluvanna counties, Va.; and in Rowan County, N. C.

Granite.—Granite is widely distributed in the Piedmont region and is quarried in Maryland, Delaware, Virginia, North Carolina, and South Carolina. Many of the quarries are close to the large cities built along the "fall line," or outer edge of the Piedmont region, such as Baltimore, Md.; Washington, D. C.; Richmond, Va.; Raleigh, N. C.; and Columbia, S. C. Gneiss is included with granite in this classification.

The Maryland granites vary in texture from fine to medium grained and from light gray to drak gray in color. In Cecil and Harford counties high-grade gneissoid granite is quarried. These outcrops are at tidewater, near the mouth of Susquehanna River, which gives the material excellent shipping facilities. Much of the Virginia granite is schistose, but the workable grades are mostly fine-grained, light to dark gray biotite granite, very similar to that of New England. In North Carolina the most important granite areas commercially are Mount Airy, in Surry County, and the Dunns Mountain, or Salisbury district, in Rowan County. At Mount Airy about 40 acres of bare rock rise 128 feet above the railroad. The stone is light gray, of medium texture, and has an excellent rift and grain. The Salisbury area contains light gray and pink granite. In South Carolina the supply of granite is abundant. The granite of Fairfield County is a fine-grained gray rock. Richland County produces a light-gray granite, from which the State capitol was erected. Much granite from North Carolina and Virginia is shipped to Northern States.

The granites of the southeastern Atlantic States have been described in detail by T. L. Watson, in Survey Bulletin 426, which is available for free distribution.

Directory.—Quarries are located in this group of States according to the following list:

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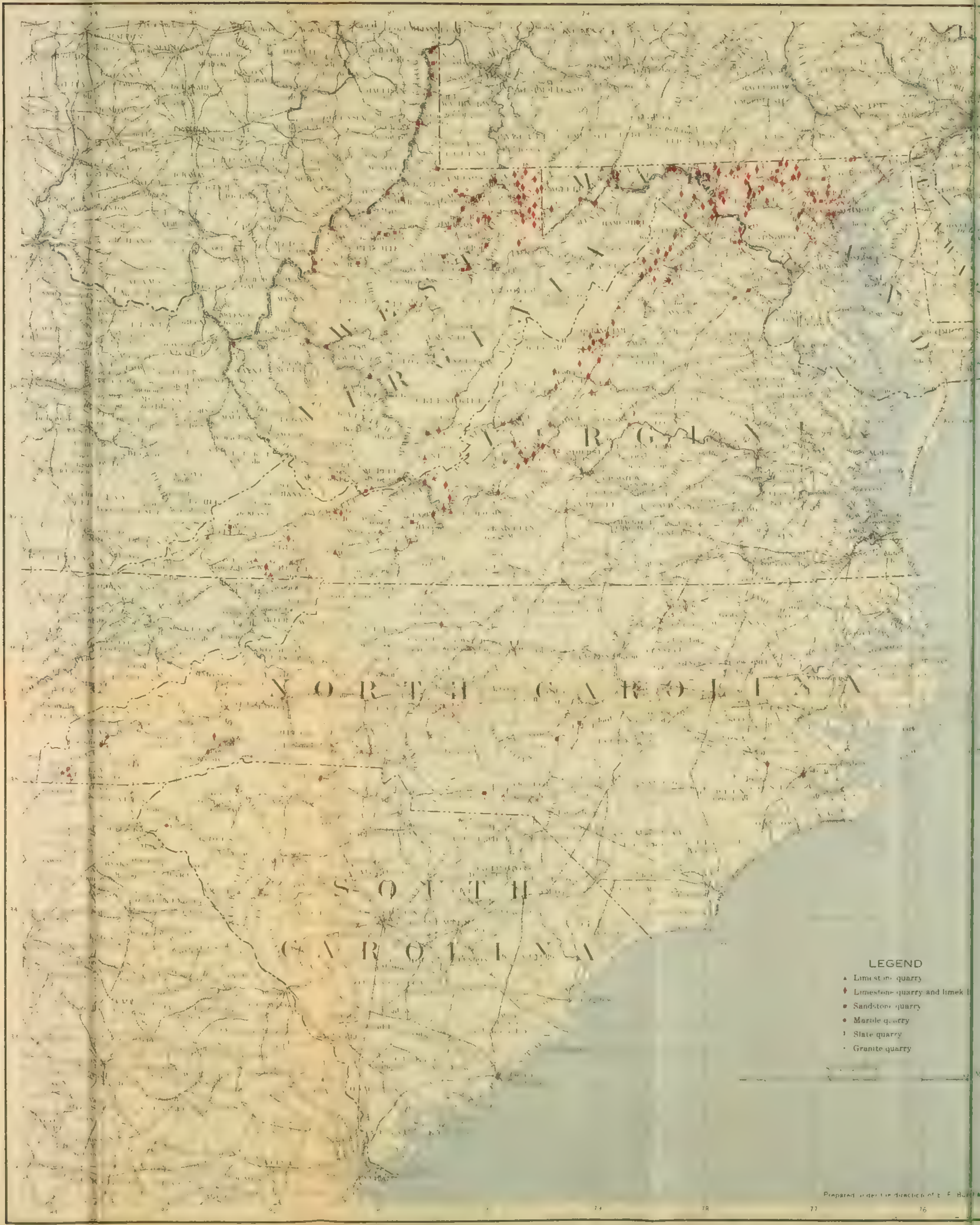
WEST VIRGINIA
VIRGINIA
NORTH CAROLINA
SOUTH CAROLINA
LEGEND
▲ Limestone quarry
♦ Limestone quarry and limek
● Sandstone quarry
● Marble quarry
Slate quarry
· Granite quarry
Miles

Prepared under the direction of E. F. Burchard

MAP OF MARYLAND, DELAWARE, VIRGINIA, WEST VIRGINIA, NORTH CAROLINA, AND SOUTH CAROLINA
Showing location of limekilns and quarries of limestone, sandstone, marble, slate, and granite

Directory of stone quarries in Maryland, Delaware, Virginia, West Virginia, North Carolina, and South Carolina.

MARYLAND.

LIMESTONE.

Allegany County:
1. Cresaptown.
2. Mount Savage.

Baltimore County:
3. Belfast.
4. Loch Raven.

Washington County:
5. Sharpsburg.

LIME AND LIMESTONE.

Allegany County:
1. Cumberland (5).

Baltimore County.
2. Cockeysville.
3. Glyndon (2).
4. Gwynbrook.

Baltimore City:
5. Baltimore (2).

Carroll County:
6. Bachmans Mills.
7. Cranberry.
8. New Windsor (2).
9. Silver Run (3).
10. Union Bridge (3).
11. Westminster (10).

Frederick County:
12. Buckeystown.
13. Catoctin.
14. Frederick (7).
15. Hansonville.
16. Le Gore.
17. Motters.
18. New London.
19. Thurmont (4).
20. Walkersville (4).

Garrett County:
21. Oakland (2).

Howard County:
22. Clarksville (3) and Highland.
23. Mariottsville.

Washington County:
24. Cavetown.
25. Clear Spring (3).
26. Eakles Mills.
27. Edgemont (2).
28. Hagerstown (7).
29. Hancock (2).
30. Maugansville.
31. Pinesburg.
32. Rohrersville.

SANDSTONE.

Allegany County:
1. Cumberland.

Baltimore County:
2. Lystra (mail Stevenson).

Carroll County:
3. Kump.
4. Taneytown (4).

Garrett County:
5. Bloomington.

Washington County:
6. Hancock.

MARYLAND—Continued.

MARBLE.

Baltimore County:
1. Cockeysville.

Baltimore City:
2. Baltimore.

Carroll County:
3. Union Bridge.

Harford County:
4. Cardiff and Whiteford.

Washington County:
5. Eakles Mills.

SLATE.

Frederick County:
1. Woodsboro.

Harford County:
2. Cardiff (4).

GRANITE.

Baltimore County:
1. Dickeyville.
2. Gardenville.
3. Granite (2).
4. Raspeburg.
5. Reisterstown.
6. Towson.
7. Whitehall.

Baltimore City:
8. Baltimore (9).

Cecil County:
9. Frenchtown.
10. Port Deposit.
11. Rising Sun.
12. Rowlandsville.

Harford County:
13. Havre de Grace (2).

Howard County:
14. Ellicott City (2).
15. Guilford.
16. Savage (2).

Montgomery County:
17. Dickerson (2).
18. Forest Glen.
19. Glen Echo.

DELAWARE.

GRANITE.

Newcastle County:
1. Bellevue.
2. Greenbank.
3. Wilmington (2).
4. Woodale.

VIRGINIA.

LIMESTONE.

Alleghany County:
1. Clifton Forge (2).
2. Longdale.
3. Lowmoor.

Botetourt County:
4. Salt Petre Cave and Springwood.

Directory of stone quarries in Maryland, Delaware, Virginia, West Virginia, North Carolina, and South Carolina—Continued.

VIRGINIA—Continued.

LIMESTONE—continued.

Giles County:
- 5. Pembrook.

Montgomery County:
- 6. Christiansburg.

Rockbridge County:
- 7. Bells Valley.

Rockingham County:
- 8. Hinton.
- 9. Timberville.

Russell County:
- 10. Fugates Hill.

Smyth County:
- 11. Marion.

Tazewell County:
- 12. Tazewell.

Washington County:
- 13. Abingdon.
- 14. Bristol.

Wise County:
- 15. Big Stone Gap.

Wythe County:
- 16. Barren Springs.
- 17. Ivanhoe.
- 18. Wytheville (3).

LIME AND LIMESTONE.

Augusta County:
- 1. Churchville (2).
- 2. Craigsville (2).
- 3. Deerfield (2).
- 4. Mossy Creek (3).
- 5. Mount Sidney.
- 6. Mount Solon (4).
- 7. Staunton (4).
- 7a. Stuarts Draft (2).

Botetourt County:
- 8. Buchanan (4).
- 9. Eagle Rock (3).
- 10. Indian Rock.
- 11. Lithia.

Frederick County:
- 12. Stephens City.
- 13. Vaucluse Station (2).
- 14. Winchester.

Giles County:
- 15. Newport.
- 16. Ripplemead.

Loudoun County:
- 17. Leesburg.
- 18. Luckets.

Montgomery County:
- 19. Blacksburg.
- 20. Radford (2).
- 21. Vicar Switch.

Norfolk County:
- 22. West Norfolk.

Page County:
- 23. Luray.

Roanoke County:
- 24. Roanoke (8).

VIRGINIA—Continued.

LIME AND LIMESTONE—continued.

Rockbridge County:
- 25. Lexington (2).
- 26. Sherwood.

Rockingham County:
- 27. Bridgewater (4).
- 28. Dayton.
- 29. Harrisonburg (2).
- 30. Linville.
- 31. Ottobine.

Russell County:
- 32. Elk Garden.

Shenandoah County:
- 33. Seven Fountains.
- 34. Strasburg (4) and Strasburg Junction (2).
- 35. Toms Brook.
- 36. Wheatfield.
- 37. Woodstock.
- 38. Zepp.

Tazewell County:
- 39. North Tazewell.

Warren County:
- 40. Limeton.
- 41. Riverton.

Washington County:
- 42. Benhams.

SANDSTONE.

Augusta County:
- 1. Basic (mail Basic City).

Campbell County:
- 2. Lynchburg.

Prince William County:
- 3. Manassas.
- 4. Nokesville.

Pulaski County:
- 5. Pulaski (2).

Wise County:
- 6. Wise.

MARBLE.

Albemarle County:
- 1. Howardsville.

Botetourt County:
- 2. Fincastle.

Loudoun County:
- 3. Leesburg.

SLATE.

Albemarle County:
- 1. Esmont.

Amherst County:
- 2. Snowden.

Buckingham County:
- 3. Arvonia (7).
- 4. Penlan.

Fluvanna County:
- 5. Palmyra.

Directory of stone quarries in Maryland, Delaware, Virginia, West Virginia, North Carolina, and South Carolina—Continued.

VIRGINIA—Continued.

GRANITE.

Alexandria County:
  1. Washington, D. C. (near).
Campbell County:
  2. Alta Vista.
  3. Lynchburg (4).
Chesterfield County:
  4. Granite (2).
  5. Manchester.
Dinwiddie County:
  6. Petersburg (4).
  7. Pride (mail Dewitt).
Fairfax County:
  8. Falls Church.
Fluvanna County:
  9. Shores.
Goochland County:
  10. Boscobel (2).
  11. Lassiter.
Greensville County:
  12. Hitchcock.
Henrico County:
  13. Richmond (8).
Loudoun County:
  14. Belmont Park.
Lunenburg County:
  15. Kenbridge.
Nelson County:
  16. Greenway.
  17. Faber.
Pittsylvania County:
  18. Danville.
Prince William County:
  19. Occoquan (2).
Spottsylvania County:
  20. Fredericksburg.
Stafford County:
  21. Falmouth (near).

WEST VIRGINIA.

LIMESTONE.

Greenbrier County:
  1. Falling Spring.
Marion County:
  2. Fairmont.
Mercer County:
  3. Bluefield.
Mineral County:
  4. Patterson Creek.
Monongalia County:
  5. Rock Forge (mail Dellslow).
Monroe County:
  6. Hunters Springs.
Ohio County:
  7. Wheeling (2).
Preston County:
  8. Buckhorn.
Upshur County:
  9. Buckhannon.

WEST VIRGINIA—Continued.

LIME AND LIMESTONE.

Berkeley County:
  1. Bunker Hill.
  2. Jones Spring.
  3. Martinsburg (5).
Greenbrier County:
  4. Fort Spring (2).
Jefferson County:
  5. Bakerton and Engle (2).
  6. Harpers Ferry (3).
  7. Kearneysville.
  8. Millville (2).
  9. Shepherdstown (3).
Mineral County:
  10. Keyser (2).
Monongalia County:
  11. Morgantown (2).
Preston County:
  12. Afton (11).
  13. Albright (7).
  14. Amboy (2).
  15. Aurora (4).
  16. Clifton Mills (3).
  17. Cranesville (7).
  18. Cuzzart.
  19. Hudson (6).
  20. Kingwood (2).
  21. Pisgah (2).
  22. Rodamers (3).
  23. Rowlesburg (3).
  24. Terra Alta (24).
  25. Valley Point (5).
Taylor County:
  26. Grafton.
  27. Pruntytown.
Tucker County:
  28. St. George (3).
Wayne County:
  29. Kenova.

SANDSTONE.

Barbour County:
  1. Junior (2).
  2. Philippi (3).
Braxton County:
  3. West Gassaway (Gassaway).

Brooke County:
  4. Wellsburg.

Fayette County:
  5. Kanawha Falls.

Hancock County:
  6. Kings Creek (mail Hollidays Cove).
  7. New Cumberland.
  8. Newell.

Harrison County:
  9. Clarksburg (2).
  10. Farnum.
  11. Viropa.

Directory of stone quarries in Maryland, Delaware, Virginia, West Virginia, North Carolina, and South Carolina—Continued.

WEST VIRGINIA—Continued.

SANDSTONE—continued.

Jackson County:
- 12. Murraysville.
- 13. Ravenswood.
- 14. Sherman.

Kanawha County:
- 15. Charleston (3) and South Charleston.
- 16. Sattes.

Lewis County:
- 17. Weston (6).

McDowell County:
- 18. Gary.

Marion County:
- 19. Downs.
- 20. Fairmont (4).
- 21. Mannington.
- 22. Rivesville.

Mercer County:
- 23. Bluefield.

Monongalia County:
- 24. Morgantown (7) and West Morgantown.

Monroe County:
- 25. Alderson.

Ohio County:
- 26. Wheeling.

Pleasants County:
- 27. St. Marys.

Preston County:
- 28. Kingwood (2).
- 29. Rowlesburg.

Ritchie County:
- 30. Cornwallis (2).
- 31. Harrisville (4).
- 32. Pullman.

Taylor County:
- 33. Grafton (5) and West Grafton.

Tyler County:
- 34. Middlebourne (2).
- 35. Sistersville (2).

Upshur County:
- 36. Buckhannon.

Wetzel County:
- 37. Littleton (2).
- 38. New Martinsville (5).

Wirt County:
- 39. Burning Springs.

Wood County:
- 40. Parkersburg (4).

MARBLE.

Hampshire County:
- 1. Hanging Rock.

Mercer County:
- 2. Willowton.

NORTH CAROLINA.

LIMESTONE.

Cherokee County:
- 1. Kinsey.

NORTH CAROLINA—Continued.

LIME AND LIMESTONE.

Craven County:
- 1. Newbern (2).

Henderson County:
- 2. Boilston (2).

Jones County:
- 3. Foys.

Transylvania County:
- 4. Brevard.

Yadkin County:
- 5. Siloam (near).

SANDSTONE.

Anson County:
- 1. Wadesboro.

Lee County:
- 2. Sanford.

Moore County:
- 3. Carthage.

MARBLE.

Cherokee County:
- 1. Kinsey.
- 2. Murphy (2).

Swain County:
- 3. Hewitts.
- 4. Nantahala.

SLATE.

Rowan County:
- 1. Salisbury.

GRANITE.

Alexander County:
- 1. Hiddenite.

Anson County:
- 2. Pee Dee.

Buncombe County:
- 3. Asheville (6).
- 4. Weaverville.

Cabarrus County:
- 5. Concord.

Cleveland County:
- 6. Shelby.

Forsyth County:
- 7. Winston-Salem.

Gaston County:
- 8. Bessemer City.
- 9. Dallas (2).
- 10. Gastonia (3).

Guilford County:
- 11. Greensboro.

Henderson County:
- 12. Balfour.
- 13. Hendersonville (2).

McDowell County:
- 14. Marion.
- 15. Old Fort.

Mecklenburg County:
- 16. Charlotte (3).

Polk County:
- 17. Rockcliff.

Directory of stone quarries in Maryland, Delaware, Virginia, West Virginia, North Carolina, and South Carolina—Continued.

NORTH CAROLINA—Continued.

GRANITE—continued.

Richmond County:
  18. Hamlet (2).
Rowan County:
  19. Bear Poplar.
  20. Faith (8).
  21. Granite Quarry (5) and Rockwell.
  22. Salisbury (2).
Surry County:
  23. Mount Airy (3).
Swain County:
  24. Whittier.
Vance County:
  25. Greystone.
  26. Henderson.
  27. Middleburg.
Wake County:
  28. Raleigh (3).
  29. Rolesville.
  30. Wendell.
Warren County:
  31. Warren Plains (2).
  32. Warrenton.
  33. Wise (2).
Wilson County:
  34. Contentnea Creek (near Wilson).

SOUTH CAROLINA.

LIME AND LIMESTONE.

Charleston County:
  1. Charleston.
Cherokee County:
  2. Gaffney.

MARBLE.

Oconee County:
  1. Westminster (2).

GRANITE.

Chesterfield County:
  1. Pageland.
Fairfield County:
  2. Blairs.
  3. Rion (2).
  4. Strother.
Greenville County:
  5. Travelers Rest.
Greenwood County:
  6. Greenwood (4).
  7. Quarry.
Lancaster County:
  8. Heath Springs.
Laurens County:
  9. Clinton.
  10. Cold Point.
Lexington County:
  11. Cayce.
  12. Lexington.
Pickens County:
  13. Easley.
Richland County:
  14. Columbia (3).
Spartansburg County:
  15. Pacolet.

TENNESSEE, MISSISSIPPI, ALABAMA, GEORGIA, AND NORTHERN FLORIDA.

All of these States are well supplied with building stones except Mississippi and Florida. With a few exceptions the hard rocks are confined to the areas underlain by Paleozoic formations, as contrasted with the areas underlain by deposits of the Coastal Plain, and the map (Pl. VIII) brings out fairly sharply the dividing line between these two provinces, which differ so markedly from each other both geologically and physiographically.

Limestone, lime, and marble.—Calcareous rocks predominate, at least so far as suitability for quarry purposes is concerned, in Tennessee, northern Alabama, and northern Georgia, and much of the limestone is suitable for the manufacture of lime. In Franklin County, Ala., are extensive quarries in an oolitic limestone that strongly resembles the famous Bedford (Ind.) limestone, and is of about the same geologic age. Much of the limestone quarried in these States is crushed for concrete, railroad ballast, wagon roads, and for fluxing iron ores. Some hard limestone occurs in Tishomingo County, Miss., but owing to the proximity of large quarries in Alabama it has not yet been utilized to an appreciable extent. In the deposits of the

Coastal Plain there are soft limestones of Cretaceous and Tertiary age. In Choctaw, Clarke, and Washington counties, Ala., these rocks are utilized. In Florida the Coastal Plain material that is utilized for stone and lime is mainly shell marl and chalky limestone.

The marble produced by this group of States is of two types. That of the Piedmont region in northwestern Georgia and east central Alabama is a true marble, much of which is beautifully white or white and veined. In Talladega County, Ala., and Cobb, Cherokee, Pickens, and Gilmer counties, Ga., and other counties in this northeast-southwest belt are situated large deposits of this type of marble. The other type is a very important marble of commerce, the highly crystalline limestone in east and central Tennessee. This formation—the Holston ("Knoxville") marble—is particularly characteristic of the Appalachian Valley and is of Ordovician age. The marble, which may be regarded as representative, is of several handsome shades, ranging from light pink to a rich chocolate color. It has been subjected to some alteration through pressure. The beds are highly tilted, and have been squeezed so as to distort the bedding planes and produce handsome veining effects called "crows' tracks." Lime is also produced in important quantities from the waste rock at certain of the marble quarries in the Knoxville district.

This type of marble is produced in Anderson, Blount, Coffee, Cumberland, Franklin, Hawkins, Knox, and Union counties, Tenn.

Sandstone.—Sandstone beds of Silurian and Carboniferous age yield the largest output of this kind of rock in these States, although in the Tertiary of the Coastal Plain there are local sandstone beds that are very firmly indurated. The Silurian and Carboniferous sandstones in Tennessee, Alabama, and Georgia are generally buff to dull red in color. They are quarried to some extent locally for building, for flagging, and for building coke ovens. Examples of sandstone quarries in the deposits of the Coastal Plain are in Holmes County, Miss., and Levy County, Fla. The material in Mississippi has not been quarried for several years.

Slate.—Slate is confined to the strongly metamorphosed areas in the Appalachian and Piedmont regions. It is quarried in east Tennessee in Blount, Monroe, Sullivan, and Washington counties, and in Georgia in Bolivar and Polk counties. The last-named county contains the well-known Rockmart slate area.

Granite.—Granite is found only in that part of the Piedmont region that extends across northwest Georgia into eastern Alabama and along the mountainous border between North Carolina and Tennessee. Granite is quarried in 18 to 20 Georgia counties. De Kalb County contains two well-known granite areas, Stone Mountain and Lithonia. Stone Mountain is an enormous granitic mass several miles in circumference and about 700 feet higher than the surrounding country. This rock has been quarried for more than half a century, and in late years developments have assumed large proportions.

The only recent record of granite quarrying in eastern Alabama was in connection with some improvement work on Chattahoochee River, where the rock was broken from the bed of the river.

Directory.—The locations of the various quarrying centers in this group of States are given in the following list:

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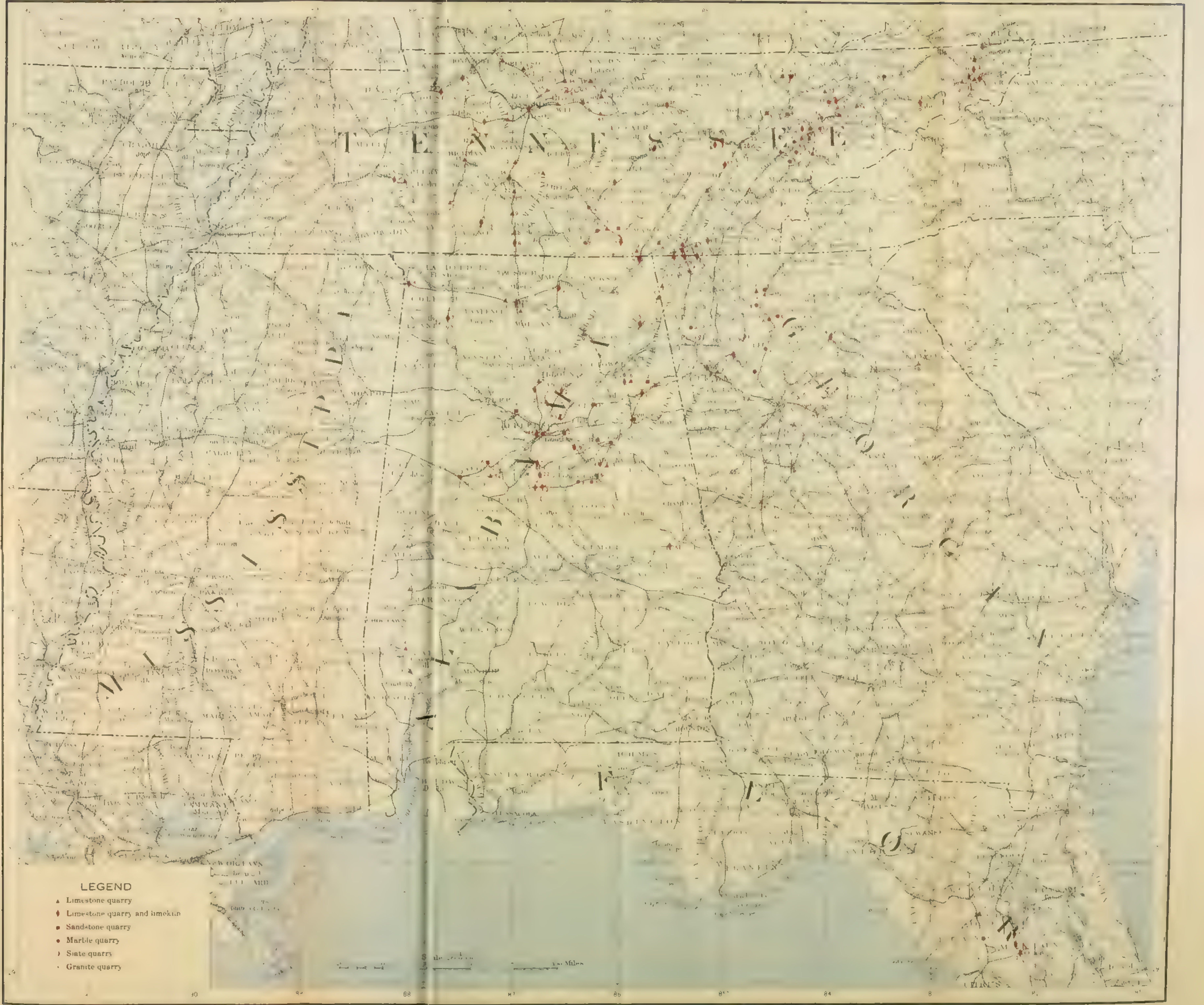
MINERAL RESOURCES 1911 PART PLATE V


TENNESSEE
MISSISSIPPI
ALABAMA
GEORGIA
FLORIDA
NEW ORLEANS
LEGEND
▲ Limestone quarry
♦ Limestone quarry and limekiln
■ Sandstone quarry
● Marble quarry
) Slate quarry
· Granite quarry
Miles

MAP OF TENNESSEE, MISSISSIPPI, ALABAMA, GEORGIA, AND NORTHERN FLORIDA
Showing location of limekilns and quarries of limestone, sandstone, marble, slate, and granite

Prepared under the direction of E. F. Burchard

Directory of stone quarries in Tennessee, Alabama, Georgia, and northern Florida.

TENNESSEE.

LIMESTONE.

Blount County:
1. Maryville.
Campbell County:
2. Lafollette.
Carter County:
3. Milligan.
Davidson County:
4. Newsoms Station (3).
Decatur County:
5. Perryville (2).
Dickson County:
6. Iron Hill.
Franklin County:
7. Winchester.
Giles County:
8. Harwell.
9. Riversburg.
Hamilton County:
10. Chattanooga (4).
11. Shepherd.
Hickman County:
12. Bon Aqua and Warner.
13. Centerville (2).
Jefferson County:
14. Jefferson City.
15. Straw Plains.
Knox County:
16. Bearden.
Loudon County:
17. Lenoir City.
Marion County:
18. Guild.
19. Richard City.
Marshall County:
20. Chapel Hill.
Maury County:
21. Carters Creek.
22. Culleoka.
Montgomery County:
23. Clarksville (2).
Rhea County:
24. Dayton.
Roane County:
25. Harriman (2).
26. Rockwood.
Robertson County:
27. Adams.
28. Springfield.
Rutherford County:
29. Murfreesboro.
Smith County:
30. Rome.
Stewart County:
31. Carlisle.
Sullivan County:
32. Bluff City.
33. Elkanah.
Sumner County:
34. Gallatin.
35. Hendersonville.

TENNESSEE—Continued.

LIMESTONE—continued.

Trousdale County:
36. Hartsville.
Union County:
37. Maynardville.
Wayne County:
38. Allens Creek.
Washington County:
39. Embreeville.
Wilson County:
40. La Guardo.
41. Lebanon (6).
42. Mount Juliet.
43. Watertown.

LIME AND LIMESTONE.

Carter County:
1. Elizabethton.
Coffee County:
2. Summitville.
Cumberland County:
3. Crab Orchard (2).
Davidson County:
4. Nashville (6).
Decatur County:
5. Parsons.
Dickson County:
6. Burns.
Franklin County:
7. Sherwood.
Giles County:
8. Aspen Hill (4).
Greene County:
9. Greeneville.
Houston County:
10. Erin (2).
James County:
11. Thatcher.
Knox County:
12. Knoxville (8).
Lawrence County:
13. Lawrenceburg.
Maury County:
14. Columbia (3).
Montgomery County:
15. Palmyra.
Putnam County:
16. Brotherton.
Rhea County:
17. Spring City.
Sullivan County:
18. Bristol.
Union County:
19. Luttrell.
Washington County:
20. Johnson City (2).
White County:
21. Doyle Station.

Directory of stone quarries in Tennessee, Alabama, Georgia, and northern Florida—Continued.

TENNESSEE—Continued.

SANDSTONE.

Anderson County:
  1. Windrock.
Campbell County:
  2. Lafollette.
Franklin County:
  3. Sewanee.
Hamilton County:
  4. Alton Park.

MARBLE.

Anderson County:
  1. Clinton.
Blount County:
  2. Friendsville (3).
  3. Meadow (near).
Coffee County:
  4. Tullahoma.
Cumberland County:
  5. Crab Orchard.
Franklin County:
  6. Maxwell.
  7. Winchester.
Hawkins County:
  8. Galbraith Springs.
Knox County:
  9. Concord.
  10. Hercules.
  11. Knoxville (11).
  12. McMillan.
Union County:
  13. Luttrell.

SLATE.

Blount County:
  1. Chilhowie.
Monroe County:
  2. Tellico Plains (2).
Sullivan County:
  3. Kingsport.
Washington County:
  4. Johnson City.
  5. Washington College.

ALABAMA.

LIMESTONE.

Blount County:
  1. Bangor (2).
  2. Dale (mail Village Springs).
Choctaw County:
  3. Naheola.
Clarke County:
  4. Coffeeville.
De Kalb County:
  5. Battelle.
Etowah County:
  6. Rock Springs.
Franklin County:
  7. Rockwood.
Jackson County:
  8. Scottsboro.

ALABAMA—Continued.

LIMESTONE—continued.

Jefferson County:
  8a. Vanns (mail Trussville).
Marshall County:
  9. Guntersville.
Morgan County:
  10. New Decatur.
  11. Trinity.
Talladega County:
  12. Stemley.
  13. Wewoka.
Tuscaloosa County:
  14. Dowdle (mail Vance).
Washington County:
  15. St. Stephens.

LIME AND LIMESTONE.

Blount County:
  1. Blount Springs (2).
  2. Chepultepec.
Calhoun County:
  3. Tredegar.
Colbert County:
  4. Denie's Kilns (Denie, mail Margerum).
De Kalb County:
  5. Fort Payne.
Etowah County:
  6. Cobb and Lagarde.
Franklin County:
  7. Russellville.
Jackson County:
  8. Bridgeport.
Jefferson County:
  9. Birmingham (3).
  10. Dolcito.
  11. Ensley.
  12. North Birmingham (2) (Lime at Ensley, North Birmingham, and Woodlawn).
  13. Thomas.
  14. Woodlawn.
Lee County:
  15. Auburn (2).
Madison County:
  16. Huntsville (4).
Morgan County:
  17. Austinville.
Shelby County:
  18. Calcis.
  19. Calera (1), Newala (2), and Steins (1).
  20. Keystone.
  21. Leeds (near).
  22. Longview (1) and Saginaw (3).

SANDSTONE.

Calhoun County:
  1. Anniston.
  2. Piedmont.
Jefferson County:
  3. Sayre.
  4. Woodlawn.

Directory of stone quarries in Tennessee, Alabama, Georgia, and northern Florida—Continued.

ALABAMA—Continued.

SANDSTONE—continued.

St. Clair County:
  5. Ragland.
Tuscaloosa County:
  6. Searles.
  7. Tuscaloosa and Northport.

MARBLE.

Calhoun County:
  1. Piedmont.
Shelby County:
  2. Calera.
Talladega County:
  3. Gantts Quarry.
  4. Sycamore (2).
  5. Sylacauga.
  6. Talladega (3).
  7. Talladega Springs.

GRANITE.

Lee County:
  1. Smiths Station.

GEORGIA.

LIMESTONE.

Dade County:
  1. Rising Fawn.
Gilmer County:
  2. Ellijay.
Polk County:
  3. Rockmart.
Walker County:
  4. Chickamauga.

LIME AND LIMESTONE.

Bartow County:
  1. Cartersville.
Catoosa County:
  2. Graysville.
Dade County:
  3. Hooker (mail Wauhatchie, Tenn.).
Hall County:
  4. Gainesville.
Polk County:
  5. Aragon.
Walker County:
  6. Rossville.

MARBLE.

Cobb County:
  1. Noonday.
Cherokee County:
  2. Holly Springs.
Floyd County:
  3. Armuchee.
Gilmer County:
  4. Ellijay.
Pickins County:
  5. Marble Hill (3).
  6. Tate.
  7. Whitestone (3).

GEORGIA—Continued.

SLATE.

Bartow County:
  1. Bolivar (mail Pinelog).
Polk County:
  2. Rockmart (7).

GRANITE.

Campbell County:
  1. Union City.
Clark County:
  2. Athens.
Cobb County:
  3. Austell.
Coweta County:
  4. Senoia.
Dekalb County:
  5. Lithonia (17).
  6. Stone Mountain (2).
Elbert County:
  7. Elberton (4).
  8. Oglesby.
Fulton County:
  9. Atlanta (2).
Hancock County:
  10. Granite Hill.
  11. Sparta.
Henry County:
  12. Stockbridge.
Jackson County:
  13. Winder (2).
Merriwether County:
  14. Woodbury.
Monroe County:
  15. Dames Ferry.
Muscogee County:
  16. Columbus.
Rockdale County:
  17. Conyers.
Spalding County:
  18. Griffin.
Stephens County:
  19. Toccoa.
Troup County:
  20. Hogansville (2) and Trimble.
Walton County:
  21. Loganville.

FLORIDA.

LIMESTONE.

Alachua County:
  1. Raleigh (near).
Dade County:
  2. Miami (2).
Duval County:
  3. Jacksonville.

LIME AND LIMESTONE.

Marion County:
  1. Kendrick (2).
  2. Ocala (2).
  3. Reddick.

SANDSTONE.

Levy County:
  1. Montbrook.

SURVEY PUBLICATIONS ON BUILDING AND OTHER STONE, SLATE, AND ROAD METAL.

The following list comprises the more important publications on stone, slate, and road metal by the United States Geological Survey. These publications, except those to which a price is affixed, can be obtained free by applying to the Director, United States Geological Survey, Washington, D. C. The priced publications may be purchased from the Superintendent of Documents, Government Printing Office, Washington, D. C. The annual volumes on Mineral Resources of the United States between 1882 and 1899 contain not only statistics of stone production but occasional discussions of available stone resources in various parts of the country. Many of the Survey's geologic folios also contain notes on stone resources that may be of local importance.

MISCELLANEOUS PUBLICATIONS.

Alden, W. C., The stone industry in the vicinity of Chicago, Ill.: Bull. 213, 1903, pp. 357–360. 25c.

Bain, H. F., Notes on Iowa building stones: Sixteenth Ann. Rept., pt. 4, 1895, pp. 500–503. $1.20.

Bastin, E. S. (See Leighton, Henry, and Bastin, E. S.)

Burchard, E. F., Concrete materials produced in the Chicago district: Bull. 340, 1908, pp. 383–410.

——— Structural materials near Austin, Tex.: Bull. 430, 1910, pp. 292–316.

——— Structural materials near Minneapolis, Minn.: Bull. 430, 1910, pp. 280–291.

——— Stone: Mineral Resources U. S. for 1909, pt. 2, 1911, pp. 569–608.

Butts, Charles, Variegated marbles southeast of Calera, Shelby County, Ala.: Bull. 470, 1911, pp. 237–239.

Clapp, F. G., Limestones of southwestern Pennsylvania: Bull. 249, 1905.

Dale, T. N., The slate belt of eastern New York and western Vermont: Nineteenth Ann. Rept., pt. 3, 1899, pp. 153–200. $2.25.

——— The slate industry of Slatington, Pa., and Martinsburg, W. Va.: Bull. 213, 1903, pp. 361–364. 25c.

——— Notes on Arkansas roofing slates: Bull. 225, 1904, pp. 414–416. 35c.

——— Slate investigations during 1904: Bull. 260, 1905, pp. 486–488. 40c.

——— Note on a new variety of Maine slate: Bull. 285, 1906, pp. 449–450. 60c.

——— Recent work on New England granites: Bull. 315, 1907, pp. 356–359.

——— The granites of Maine: Bull. 313, 1907, 202 pp.

——— The chief commercial granites of Massachusetts, New Hampshire, and Rhode Island: Bull 354, 1908, 228 pp.

——— The granites of Vermont: Bull. 404, 1909, 138 pp.

——— Supplementary notes on the granites of New Hampshire: Bull. 430, 1910, pp. 346–372.

——— Supplementary notes on the commercial granites of Massachusetts: Bull. 470, 1911, pp. 240–290.

——— The commercial marbles of western Vermont: Bull. 521, 1912. (In press.)

——— and Gregory, H. E., The granites of Connecticut: Bull. 484, 1911, 137 pp.

——— and others, Slate deposits and slate industry of the United States: Bull. 275, 1906, 154 pp. 15c.

Darton, N. H., Marble of White Pine County, Nev., near Gandy, Utah: Bull. 340, 1908, pp. 377–380.

——— Structural materials near Portland, Oreg., and Seattle and Tacoma, Wash.: Bull. 387, 1909, 36 pp.

Diller, J. S., Limestone of the Redding district, California: Bull, 213, 1903, p. 365. 25c.

Eckel, E. C., Slate deposits of California and Utah: Bull. 225, 1904, pp. 417–422. 35c.

——— Cement materials and industry of the United States: Bull. 243, 1905, 395 pp. Edition exhausted. (Treats of limestone.)

ECKEL, E. C., and BURCHARD, E. F., Portland cement materials and industry of the United States: Bull. 522, 1912. (Treats of limestone.) (In press.)

GARDNER, JAMES H., Oolitic limestone at Bowling Green and other places in Kentucky: Bull. 430, 1910, pp. 373–378.

HILLEBRAND, W. F., Chemical notes on the composition of the roofing slates of eastern New York and western Vermont: Nineteenth Ann. Rept., pt. 3, 1899, pp. 301–305. $2.25.

HOPKINS, T. C., The sandstones of western Indiana: Seventeenth Ann. Rept., pt. 3 (continued), 1896, pp. 780–787. $1.00.

——— Brownstones of Pennsylvania: Eighteenth Ann. Rept., pt. 5 (continued), 1897, pp. 1025–1043. $1.00.

——— and SIEBENTHAL, C. E., The Bedford oolitic limestone of Indiana: Eighteenth Ann. Rept., pt. 5 (continued), 1897, pp. 1050–1057. $1.00.

HUMPHREY, R. L., The fire-resistive properties of various building materials: Bull. 370, 1909, 99 pp. 20c.

KEITH, A., Tennessee marbles: Bull. 213, 1903, pp. 366–370. 25c.

LEIGHTON, HENRY, and BASTIN, E. S., Road materials of southern and eastern Maine: Bull. 33, Office of Public Roads, Department of Agriculture, 1908. (May be obtained from Department of Agriculture.)

LOUGHLIN, G. F., The gabbros and associated rocks at Preston, Conn.: Bull. 492, 1912, 158 pp.

PAIGE, SIDNEY, Marble in Chiricahua Mountains, Arizona: Bull 380, 1909, pp. 299–311.

PURDUE, A. H., The slates of Arkansas: Bull. 430, 1910, pp. 317–334.

RIES, H., The limestone quarries of eastern New York, western Vermont, Massachusetts, and Connecticut: Seventeenth Ann. Rept., pt. 3 (continued), 1896, pp. 795–811. $1.00.

SHALER, N. S., Preliminary report on the geology of the common roads of the United States: Fifteenth Ann. Rept., 1895, pp. 259–306. $1.70.

——— The geology of the road-building stones of Massachusetts, with some consideration of similar materials from other parts of the United States: Sixteenth Ann. Rept., pt. 2, 1895, pp. 277–341. $1.25.

SIEBENTHAL, C. E., The Bedford oolitic limestone [Indiana]: Nineteenth Ann. Rept., pt. 6 (continued), 1898, pp. 292–296. $1.00.

——— (See also Hopkins, T. C., and Siebenthal, C. E.)

SMITH, G. O., The granite industry of the Penobscot Bay district, Maine: Bull. 260, 1905, pp. 489–492. 40c.

UDDEN, JON A., Oolitic limestone industry at Bedford and Bloomington, Ind.: Bull. 430, 1910, pp. 335–345.

WATSON, T. L., Granites of the southeastern Atlantic States: Bull. 426, 1910, 282 pp.

STONE AND SLATE STATISTICS.

The statistical reports on the production of stone, etc., will be found in the following volumes of Mineral Resources of the United States:

1882. Structural materials, pp. 450–464, 50c.
1883–4. Structural materials, pp. 662–670, 60c.
1885. Structural materials, by H. H. Sproull, pp. 396–413. 60c.
1886. Structural materials, by Wm. C. Day, pp. 517–566, 40c.
1887. Structural materials, by Wm. C. Day, pp. 503–534, 50c.
1888. Structural materials, by Wm. C. Day, pp. 516–557, 50c.
1889–90. Stone, by Wm. C. Day, pp. 373–440. 50c.
1891. Stone, by Wm. C. Day, pp. 456–473, 50c.
1892. Stone, by Wm. C. Day, pp. 704–711, 50c.
1893. Stone, by Wm. C. Day, pp. 543–602, 50c.
1894. Sixteenth Ann. Rept., U. S. Geol. Survey, pt. 4, Nonmetallic products.
    Stone, by Wm. C. Day, pp 436–510.
1895. Seventeenth Ann. Rept., U. S. Geol. Survey, pt. 3 (continued), Nonmetallic products, except coal.
    Stone, by Wm. C. Day, pp. 759–811.
1896. Eighteenth Ann. Rept., U. S. Geol. Survey, pt. 5 (continued), Nonmetallic products, except coal.
    Stone, by Wm. C. Day, pp. 948–1068.

1897. Nineteenth Ann. Rept., U. S. Geol. Survey, pt. 6 (continued), Nonmetallic products, except coal and coke.
Stone, by Wm. C. Day, pp. 205–309.
1898. Twentieth Ann. Rept., U. S. Geol. Survey, pt. 6 (continued), Nonmetallic products, except coal and coke.
Stone, by Wm. C. Day, pp. 269–464.
1899. Twenty-first Ann. Rept., U. S. Geol. Survey, pt. 6 (continued), Nonmetallic products, except coal and coke.
Stone, pp. 333–360.
1900. Stone, pp. 661–692, 70c.
1901. Stone, pp. 641–666, 70c.
1902. Stone, pp. 665–701.
1903. Stone, pp. 755–789, 70c.
1904. Stone, pp. 801–841.
1905. Slate, by A. T. Coons, pp. 1011–1017; Stone, by A. T. Coons, pp. 1021–1067, $1.00.
1906. Slate, by A. T. Coons, pp. 1001–1005; Stone, by A. T. Coons, pp. 1007–1041.
1907. Slate, by A. T. Coons, pt. 2, pp. 557–562; Stone, by A. T. Coons, pt. 2, pp. 563–605, 50c.
1908. Slate, by A. T. Coons, with general note on the classification and characteristics of slate, by T. Nelson Dale, pt. 2, pp. 521–532; Stone, by A. T. Coons, pt. 2, pp. 533–579, 80c.
1909. Slate, by A. T. Coons, pt. 2, pp. 557–568; Stone, by E. F. Burchard, pt. 2, pp. 569–608.
1910. Slate, by A. T. Coons, pt. 2, pp. 627–641; Stone, by E. F. Burchard, pt. 2, pp. 643–682.
Portland cement materials, by E. F. Burchard, pt. 2, pp. 488–535. (Discussion of limestones.)
1911. Slate, by A. T. Coons, pt. 2; Stone, by E. F. Burchard, pt. 2.

ABRASIVE MATERIALS.

By W. C. Phalen.

REVIEW OF THE ABRASIVE INDUSTRY IN 1911.

The abrasive industry showed a gain in 1911 compared with 1910. Though the total value of abrasive materials entering the trade fell off, the decline was in the importation and not in the domestic production, which increased $8,968 in value. The value of the natural abrasives produced increased $119,958, which was more than enough to offset the decrease in the value of the artificial abrasives—$110,990. The fact that the decline in the total figures is attributable chiefly to the falling off in imports is a good indication of an increasingly healthy condition in the domestic industry.

In the natural-abrasive industry gains were shown in the production of millstones and quarry products made in connection with them, such as chasers and drag stones, of grindstones and pulpstones, of abrasive garnet, and of infusorial earth and tripoli. There was a slight decrease in the value of the oilstones and scythestones produced. The falling off in the emery industry was marked—the value of the product declining more than 50 per cent compared with 1910. There was also a small decrease in the production of pumice, which is to be explained in part by the buying up of larger stocks than were necessary in 1910.

The total estimated value of all the abrasive materials consumed in the United States during the five years 1907 to 1911 is given in the following table:

Total value of all abrasive materials consumed in the United States, 1907–1911.

Year.	Natural abrasives.	Artificial abrasives.	Imports.	Total value.
1907	$1,680,737	$1,027,246	$754,140	$3,462,123
1908	1,074,039	626,340	476,073	2,176,452
1909	1,329,750	1,365,820	653,779	3,349,349
1910	1,406,805	1,604,030	977,718	3,988,553
1911	1,526,763	1,493,040	705,420	3,725,223

NATURAL ABRASIVES.

Under the head of natural abrasives in this report are included (1) millstones; (2) grindstones and pulpstones; (3) oilstones and scythestones; (4) corundum and emery; (5) abrasive garnet; (6) infusorial earth and tripoli; and (7) pumice. The difficulty of separating abrasive quartz and feldspar from the quartz and feldspar produced for other purposes has led to their omission from the chapter on abrasives, and such information as appears about them in this volume will be found in the chapter entitled "Quartz and feldspar." The statistics in this report represent only that part of the production of natural abrasives that properly comes under the abrasive industry, except as indicated below; thus only a small percentage of the sandstone that is quarried is used in the manufacture of abrasives—grindstones and pulpstones—the remainder being used chiefly in the building industry. There is difficulty in separating that portion of the production of tripoli and infusorial earth which is used as an abrasive from that which is not; hence the production of these substances is given in full. A large part of both of these products is not used as an abrasive but is applied to other and diverse uses. Infusorial earth, for example, which is a nonconductor of heat and is of light weight, is used extensively as a packing material for furnaces, steam pipes, and boilers and as a fireproof building material. Similarly, tripoli, in addition to being ground and used as an abrasive, is used as a filtering medium, etc. Almost the entire output of millstones, pumice, emery, and garnet (except gem garnet) is used in the abrasive industry.

It is the aim to give in this report from year to year detailed descriptions of the various abrasive industries. In the present report are described in considerable detail (1) the millstone quarry industry as carried on in New York and Virginia, (2) the oilstones of Arkansas, (3) garnet milling in New Hampshire, and (4) the deposits of diatomaceous earth in the vicinity of Richmond, Va. In the report for 1910 the emery deposits of New York were described, as was also the garnet industry in the same State; infusorial earth and its possible applications were dealt with in considerable detail, and the artificial abrasive alundum was discussed. In previous years other or the same subjects were described. Thus it is aimed to cover the entire field of abrasives every few years. The chapters therefore serve as a contemporary review of the conditions in the abrasive industry. It may be added that in many branches of the industry the descriptions published a few years ago still hold good, as the industry is one which does not change rapidly.

Natural abrasives were produced in 1911 in 24 States, which are listed below.

ALABAMA: Millstones.
ARKANSAS: Oilstones.
CALIFORNIA: Infusorial earth.
COLORADO: Grindstones.
CONNECTICUT: Infusorial earth.
ILLINOIS: Tripoli.
INDIANA: Oilstones.
KANSAS: Pumice.
KENTUCKY: Oilstones.
MARYLAND: Infusorial earth.
MASSACHUSETTS: Emery and infusorial earth.
MICHIGAN: Grindstones and scythestones.
MISSOURI: Tripoli.
MONTANA: Grindstones.
NEBRASKA: Pumice.
NEVADA: Infusorial earth.
NEW HAMPSHIRE: Garnet and scythestones.
NEW YORK: Millstones, emery, garnet, and infusorial earth.
NORTH CAROLINA: Millstones and garnet.
OHIO: Grindstones, pulpstones, oilstones, scythestones.
PENNSYLVANIA: Millstones.
VERMONT: Scythestones.
VIRGINIA: Millstones and infusorial earth.
WEST VIRGINIA: Grindstones.

In 1911 Kentucky has been added to the list as a producer of oilstones, Montana as a producer of grindstones, and Nevada as a producer of infusorial earth. The output of these commodities in these States is small.

In the following table is given the value of the natural abrasive materials produced during the last five years:

Value of natural abrasives produced in the United States, 1907–1911.

Kind of abrasives.	1907	1908	1909	1910	1911
Millstones	$31,741	$31,420	$35,393	$28,217	$40,069
Grindstones and pulpstones	896,022	536,095	804,051	796,294	907,316
Oilstones and scythestones	264,188	217,284	214,019	228,694	214,991
Corundum and emery	12,294	8,745	18,185	15,077	6,778
Garnet	211,686	64,620	102,315	113,574	121,748
Abrasive quartz and feldspar	126,582	79,146	(a)	(a)	(a)
Infusorial earth and tripoli	104,406	97,442	122,348	130,006	147,462
Pumice	33,818	39,287	33,439	94,943	88,399
Total	1,680,737	1,074,039	1,329,750	1,406,805	1,526,763

(a) See chapter on quartz and feldspar.

MILLSTONES.

PRODUCTION.

The production of millstones in the United States in 1911 amounted to $40,069 in value, an increase of $11,852, or 42 per cent compared with the value reported to the Survey in 1910. The production of millstones, chasers, etc., in this country in 1911 is the largest since 1906, when it amounted to $48,590. For the last 25 years the returns to the Survey from this industry have shown great fluctuations, which have been difficult to account for satisfactorily. It is natural to suppose that the market for millstones, made as they are from quartz conglomerate, would have declined in recent years because of the introduction of other grinding machinery. The replacement of the millstones, it is but natural to assume, would be gradual, and the value of millstones would therefore show a steady falling off. This, however, has not been the case. From a maximum value of $200,000 in 1880 the value of millstones fell to $100,000 in 1887; from $81,000 in 1888 the value declined rapidly to $16,587 in 1891; in the following year there was a rise in value to $23,417, followed by a marked decline in the two following years, until the lowest production ever reported, namely, $13,887, was reached in 1894. Since that year the values have risen and fallen, as will be observed from the table of production, without any apparent rule. One fact, however, is to be noted, which is that the value of the production has maintained a much higher average than for the year 1894, when its lowest point was reached.

Millstones were produced in 1911 in Alabama, New York, North Carolina, Pennsylvania, and Virginia, the same States that produced them in 1910. The output in New York was about the same as in 1910. Virginia's production increased notably and this State now leads in the millstone industry in the United States.

In the following table is given the value of millstones, chasers, and rider or drag stones produced in the United States from 1907 to 1911, inclusive:

Value of millstones produced in the United States, 1907–1911, by States.

State.	1907	1908	1909	1910	1911
New York	$23,072	$18,341	$13,138	$13,753	$13,335
Virginia	4,684	7,954	22,255	5,273	17,635
North Carolina	1,969	4,052		9,191	9,099
Pennsylvania	2,016	1,073			
Alabama					
Total	31,741	31,420	35,393	28,217	40,069

The following table gives the value of millstones, etc., produced in the United States since 1880:

Value of millstones produced in the United States, 1880–1911.

1880	$200,000	1896	$22,567
1881	150,000	1897	25,932
1882	200,000	1898	25,934
1883	150,000	1899	28,115
1884	150,000	1900	32,858
1885	100,000	1901	57,179
1886	140,000	1902	59,808
1887	100,000	1903	52,552
1888	81,000	1904	37,338
1889	35,155	1905	37,974
1890	23,720	1906	48,590
1891	16,587	1907	31,741
1892	23,417	1908	31,420
1893	16,639	1909	35,393
1894	13,887	1910	28,217
1895	22,542	1911	40,069

IMPORTS.

The imports of burrstones and millstones for consumption into the United States in 1911 amounted in value to $36,028 as compared with $34,763 in 1910. The increase took place in the material imported in the rough, the imports of finished stones having declined slightly as compared with 1910. The imports of finished material have always been slight, and they amounted to only $875 in value during 1911. The value of the imports of burrstones and millstones during the last five years is given in the following table:

Value of burrstones and millstones imported and entered for consumption in the United States, 1907–1911.

Year.	Rough.	Made into millstones.	Total.	Year.	Rough.	Made into millstones.	Total.
1907	$26,431	$877	$27,308	1910	$33,740	$1,023	$34,76
1908	16,075	2,567	18,642	1911	35,153	875	36,02
1909	22,125	465	22,590				

THE MILLSTONE INDUSTRY.

In this report for 1909 notes were given on the millstone industry in New York and Virginia. The industry is one which undergoes little change from year to year, and statements made in the former report still hold; the descriptions are therefore given again below.

New York.—New York has led for many years in the production of millstones and chasers, the latter term being applied to stones which run on edge or on a horizontal shaft. The raw material is obtained in Ulster County, southeastern New York, and is known as Esopus stone, Esopus being an early name for Kingston, which was formerly the main point of shipment. The material suitable for millstones is quarried from the Shawangunk conglomerate, which is found near the western base of Shawangunk Mountain, in the valley of Rondout River. The material suitable for millstones is exceedingly scanty, being confined in linear extent to a strip extending from High Falls on the north to Kerhonkson on the south, a distance of approximately 10 miles. Beyond these limits the texture and other properties of the rock have been found unsuitable for the highest grade of stones.

The methods employed in quarrying the rock are simple. The rock is pried or split out, advantage being taken of the joint planes, especially the concentric surface joints. The tools used are the ordinary hand drill, together with plugs and feathers. Blasting is often resorted to, but the charges of powder are usually light. The rough stones thus obtained are quarry dressed and finished, these operations being performed entirely by hand, the chief tools employed being the bull point and the hammer. The operation of drilling the "eye" is performed by centering the stone and then drilling from the center of both faces inward. In many stones the eye is square. To fashion a square eye a round eye is first drilled out and then squared up. A few of the men engaged in the industry make a modification of the regular millstone for use in grinding paint. In this modification the ordinary millstone is cut in halves and an iron casting is placed between the halves, which are then joined together by an iron band.

Chasers are larger than the regular millstones. They are used for heavier work, such as grinding quartz, feldspar, barytes, etc., and, as already mentioned, they run on edge. Though they are made with a diameter as short as 24 inches, they are usually turned out with diameters ranging from 50 to 84 inches, and are as much as 22 inches in thickness. These chasers are run on pans paved with roughly cubical blocks of the conglomerate, with edges about a foot in length. In grinding quartz in such pans the chasers are used in the preliminary crushing; then rough blocks, usually three in number, are either attached to or carried along by lateral arms, which in turn are joined to a vertical revolving shaft. By the circular movement of these blocks the material placed in the pan is ground to powder.

Virginia.—The millstone industry in Virginia is confined to quarries near Prices Fork, Montgomery County, about 5 miles west of Blacksburg, the site of the Virginia Polytechnic Institute. The rock is regarded as of Mississippian (lower Carboniferous) age. The material from which the stones are quarried varies from a normal conglomerate to a fine-grained quartzitic rock. It includes pebbles, some of them as large as walnuts, though most of them are smaller.

The rock has a bluish cast. Its bedding planes are very distinct, and layers only an inch thick may be observed. It is extremely hard and tough and resists erosion to a marked degree. It underlies Brush Mountain for miles, and for this reason the millstones are frequently termed Brush Mountain stones. The stone can not be quarried by blasting, and it is therefore extracted by hand power, with drill and hammer, plug and feathers. Millstones and drag or rider stones are the principal products made at the Virginia quarries.

GRINDSTONES AND PULPSTONES.

PRODUCTION.

The value of the grindstones and pulpstones produced in the United States in 1911 was $907,316, an increase of $111,022, or 14 per cent, as compared with the value for 1910. The great increase appears in the value of the grindstones, the value of pulpstones having declined as compared with 1910. As stated in the reports for the last two years, the grindstone industry is in a normally healthy condition and, although the output for 1910 was slightly below that for 1909, the advance in value of production has been steady, barring of course the depression in the grindstone and all other industries in 1908. In 1911, for the first time in the history of the grindstone and pulpstone industry, the value of the production amounted to more than $900,000.

In the following table is given the value of grindstones and pulpstones during the five years 1907 to 1911, inclusive:

Value of the production of grindstones and pulpstones, 1907–1911.

	1907	1908	1909	1910	1911
Grindstones	$846,522	$495,495	$768,651	$746,294	$865,316
Pulpstones	49,500	40,600	35,400	50,000	42,000
Total	896,022	536,095	804,051	796,294	907,316

The States producing grindstones and pulpstones in 1911 were Ohio, Michigan, West Virginia, Montana, and Colorado, the production of the first two States named being by far the most important. Ohio as usual maintained the leading position in the industry, the value of the grindstone production of the State being between four and five times that of Michigan. Ohio also produced pulpstones. The output of grindstones in West Virginia, though still small as compared with that of the two leading States, showed rapid growth. The production in Colorado and Montana was very small.

The following table shows the value of grindstones and pulpstones produced in the United States from 1907 to 1911, by States:

Value of grindstones and pulpstones produced in the United States, 1907–1911, by States.

State.	1907	1908	1909	1910	1911
Ohio	$764,276	$482,128	$679,930	$699,033	$742,107
Michigan	(a)	(a)	(a)	(a)	(a)
West Virginia and Colorado	131,746	53,967	[b] 124,121	[b] 97,261	[c] 165,209
Total	896,022	536,095	804,051	796,294	907,316

[a] Included with West Virginia, etc. [b] Includes Michigan. [c] Includes Michigan and Montana.

The value of the production of pulpstones and grindstones in the United States from 1880 to 1911, inclusive, is shown in the following table:

Value of grindstones and pulpstones produced in the United States, 1880–1911.

1880	$500,000	1896	$326,826
1881	500,000	1897	368,058
1882	700,000	1898	489,769
1883	600,000	1899	675,586
1884	570,000	1900	710,026
1885	500,000	1901	580,703
1886	250,000	1902	667,431
1887	224,400	1903	721,446
1888	281,800	1904	881,527
1889	439,587	1905	777,606
1890	450,000	1906	744,894
1891	476,113	1907	896,022
1892	272,244	1908	536,095
1893	338,787	1909	804,051
1894	223,214	1910	796,294
1895	205,768	1911	907,316

IMPORTS.

The value of the imports of grindstones and pulpstones increased in 1911, amounting to $123,727 as compared with $106,596 in 1910. This is the greatest importation recorded during the last five years but was exceeded by that for 1906, which amounted to $134,136.

The imports for the last five years are given in the following table:

Value of pulpstones and grindstones imported and entered for consumption in the United States, 1907–1911.

1907	$111,495	1910	$106,596
1908	80,382	1911	123,727
1909	99,153		

CANADIAN PRODUCTION.

The value of the production of grindstones in Canada during 1911 amounted to $49,942, as compared with $43,936 in 1910. In the following table is given the value of the Canadian production of grindstones during the last five years:

Value of production of grindstones in Canada, 1907–1911.

1907	$60,376	1910	$43,936
1908	45,128	1911	49,942
1909	50,944		

OILSTONES AND SCYTHESTONES.

PRODUCTION.

The production of oilstones and scythestones in the United States during 1911 amounted to $214,991 in value, a decrease of $13,703 as compared with the value for 1910. Oilstones were produced in Arkansas, Indiana, Ohio, and Kentucky, especially in Arkansas, which has led in the production for many years. New Hampshire led in the production of scythestones, but Vermont, Michigan, and

Ohio also contributed important quotas. A description of the scythestone industry in New Hampshire was given in this report for 1909. In the following table is given the value of oilstones and scythestones produced in the United States since 1891:

Value of oilstones and scythestones produced in the United States, 1891–1911.

1891	$150,000	1902	$221,762
1892	146,730	1903	366,857
1893	135,173	1904	188,985
1894	136,873	1905	244,546
1895	155,881	1906	268,070
1896	127,098	1907	264,188
1897	149,970	1908	217,284
1898	180,486	1909	214,019
1899	208,283	1910	228,694
1900	174,087	1911	214,991
1901	158,300		

IMPORTS.

The following table shows the value of all kinds of hones, oilstones, and whetstones imported into the United States in the last five years:

Value of imports of hones, oilstones, and whetstones, 1907–1911.

1907	$89,939	1910	$45,819
1908	44,304	1911	54,379
1909	68,018		

OILSTONES OF ARKANSAS.[1]

There are two kinds of whetstones or oilstones quarried in Arkansas. They come from the vicinity of Hot Springs, Garland County, and are known as Arkansas stone and Ouachita[2] stone. In the trade two grades of each of these stones are recognized, namely, the hard and the soft varieties. Each stone has its own uses and is adapted to particular tools.

ARKANSAS STONE.

Properties.—The Arkansas stone is a true novaculite; that is, it is homogeneous, gritty, has a finely granular structure, and a siliceous composition. It is translucent on the edges and has a pronounced conchoidal fracture. The following is an average of several chemical analyses made of the Arkansas stone:

Average analysis of Arkansas novaculite.

Silica (SiO_2)	99.50
Alumina (Al_2O_3)	.20
Iron (ferric) oxide (Fe_2O_3)	.10
Lime (CaO)	.10
Magnesia (MgO)	.05
Potash (K_2O)	.10
Soda (Na_2O)	.15
Loss on ignition (water)	.10
	100.30

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[1] From notes made after personal observation by the writer, and from report of L. S. Griswold, Geo. Survey Arkansas, vol. 3, 1892.

[2] Spelled also "Washita." The latter form is used almost exclusively in the trade.

The most striking point brought out in this analysis, which is a fair average for this stone, is the very constant and high percentage of silica—which, it may be added, is present in a very stable, that is, insoluble form. The microscopic examination of thin sections of the Arkansas stone gives results which agree with the conclusions drawn from the chemical analyses. Nothing but silica can be seen. The silica is present in minute irregular grains closely crowded together to form a dense groundmass. The grains are very uniform in size and average less than 0.01 millimeter in diameter. As the silica of the novaculite is neither crystalline, amorphous, nor chalcedonic, it must be classed with the cryptocrystalline minerals—those too fine to show distinctive characters.

The arrangement of the silica in the thin sections is a matter of interest. The groundmass is composed of densely crowded grains of silica, but here and there are little cavities with rhombic outlines, indicating the former presence of calcite now dissolved away. The cavities average about 0.05 millimeter in diameter. Occasionally these cavities are filled with secondary silica forming a larger grain than usual. These larger grains have some influence on the abrasive qualities of the Arkansas stone, but the cavities probably have more.

The Arkansas stone, when fresh, has a white color with a slightly bluish watery tint. Oil soon gives it a green tinge. Often it is tinged brownish or reddish by diffused oxide of iron. The bluish tint and translucent properties give it a striking resemblance to chalcedony, but it does not contain any of the latter mineral.

The Arkansas novaculite can not be scratched by a knife point. Quartz will scratch it, however, and likewise it will scratch quartz; hence its hardness may be considered that of this mineral. It is not tough like flint, but it is brittle and easily chipped with a hammer, though its fracture is quite as irregular as that of flint. It drills at the rate of about a foot in two hours with a 1¼-inch drill with two men striking. Ouachita stone drills about three times as fast.

Experiments on the absorption of water by this stone and the Ouachita stone indicate that both are very dense and practically the same so far as effectiveness of abrasion depending upon porosity is concerned. The actual space in the Arkansas stone is about 0.0017 of the total bulk. This is very small, but it seems to give the stone considerable advantage as a whetstone over the perfectly dense stones.

Occurrence.—The novaculite usually occurs in massive strata, usually presenting plane surfaces and having only thin layers of shale interbedded. The common thickness of the novaculite formation is 500 or 600 feet, which includes generally some flinty shales and soft shales or sandstones. The novaculite, however, is the prominent portion of the formation and occurs in massive beds from a few inches to 12 or 15 feet in thickness. The massive beds are so closely associated that there often appears to be no parting between them, but stratification lines are indicated in quarries by thin seams of clay.

The region in which the stone is found has been subjected to pressure and the strata are commonly found in a position nearer vertical than horizontal. The quarries are therefore narrow, slanting, open cuts conforming to the bedding. The brittle novaculite, as a result of the pressure, has in many places been crushed into fragments and in other places has developed natural cleavages or joint planes called by the quarrymen "splitting seams." Two or three may be found at almost any place, and as many as six have been observed in a single quarry. In addition to the local hard or tougher spots and cracks presenting difficulty to prospectors, fine quartz veins intersect the rock in all directions and in great numbers. Some of them are so thin that they can not be distinguished with the naked eye. Since they do not always appear at the surface, they are frequently not found until the stone has been sawed, in such cases occasioning considerable loss. On account of the occurrence of these small quartz veins, manufacturers prefer blocks of medium rather than of large size. Finally, small cavities known as "sand holes" may be present.

Manufacture and uses.—The workable stone is obtained usually in rather small pieces. The blocks of stone are trimmed at the quarries. In the case of the hard Arkansas stone, anything weighing over 5 pounds is shipped. In the case of the soft Arkansas stone, anything weighing more than 15 pounds is shipped. The blocks are sent to various abrasive factories in different parts of the country, and are there sawed and rubbed into forms in which they are used. The stones are used in a variety of ways by engravers, carvers, dentists, jewelers, especially manufacturing jewelers and watchmakers, cutlers, manufacturers of fine edged tools in general, machinists and woodworkers, manufacturers of fine machinery and metal work—in short, by all artisans who use small pointed or fine edged tools. Various forms of the stone are turned out depending upon the use to which they are to be put; dentists have certain shapes applicable in their work; carvers and jewelers need other forms. The stone is well suited for small files and points, but small articles made from it must be used with care on account of its brittleness. Wheels also have been made from this stone.

OUACHITA (WASHITA) STONE.

Properties.—The Ouachita stone resembles the Arkansas stone in all its physical characters, but it is less dense and more porous, its porosity excluding it from the class of true novaculites. As a result of its porosity it lacks the waxy luster of novaculite and has the dead appearance of unglazed chinaware. Instead of the fine conchoidal fracture of the Arkansas stone it has a subconchoidal fracture.

It has the same chemical composition as the Arkansas stone and its percentage of soluble silica is less than that of quartz crystals, which is 4 per cent, and is therefore less than that of the Arkansas stone, which is 5 per cent. Its remarkable abrasive qualities depend upon the existence of many cavities in a dense groundmass. As in the Arkansas stone, these cavities have a rhombohedral form, but they are more important in the Ouachita stone as here they are larger and much more numerous. The silica is more compact about the cavities than elsewhere, as a result of which their sides present fine cutting edges to a tool rubbed on the stone. These edges must accomplish the cutting, for the Ouachita stone differs from the Arkansas stone in no other way that could account for its much greater abrasive powers. The cavities of the Arkansas stone amount to 0.25 per cent of the total bulk; in the densest of the Ouachita stone the pores constitute about 5 per cent.

The Ouachita stone resembles the Arkansas stone in its mode of occurrence. There is nothing in the structure of the two stones to render impossible the gradation from one into the other in the same bed, but such transition is rarely observed. The defects that are met with in the Arkansas stone are also common in the Ouachita stone. Like the Arkansas stone it may be intersected by joint planes, which divide it into fragments too small for use. However, the Ouachita stone is freer from defects than the Arkansas stone, and some masses weighing several tons are quarried. The hard spots in the Ouachita stone are not flinty in appearance but appear to be simply dense portions of the stone, which in use are liable to glaze. They may be the result of a mineral cement binding the grains more firmly in those particular places, or they may be due to the smaller number of cavities in that particular part of the stone. Quartz veins are not so numerous in the Ouachita stone as in the Arkansas stone. "Sand holes" are, however, more numerous and attain a larger size than in the Arkansas stone. Freezing does not have the injurious effect on the Ouachita stone that it does on the Arkansas stone, for the former is porous enough to allow some expansion. Long drying is injurious, for it seems to cause loss of easy fracture and to make the stone tougher and harder. For this reason it seems inadvisable to keep the stone a long time before shipping to the factory, or to hold it at the factory a long time before sawing. It saws more readily when fresh from the quarry. A defect in the stone from some quarries is due to the uneven distribution of the rhombic cavities. The change occurs in the stratification planes and shows that the amount of calcite deposited in the original stone varied at different times. As a result, the stone is composed of bands of different densities which appear in the finished product as areas of unequal hardness. Ouachita stone has been found in much larger quantity than Arkansas stone, a fortunate circumstance, for the demand for the former is much greater than for the latter. As already stated, Ouachita stone is shipped in much larger blocks than Arkansas stone, blocks of 40 to 50 pounds being about as small as manufacturers care to buy, for small blocks produce more waste. From this minimum the blocks of Ouachita stone vary in weight up to 1,500 pounds and even more.

Manufacture.—The same machinery and methods are used in the manufacture of Ouachita stone as in that of Arkansas stone. The former is, however, handled in larger quantity, hence a regular system of sawing can be employed. The first cuts are 2 inches apart; the 2-inch slabs are cut into 8-inch lengths, and these into whetstones 1⅛ inches in thickness. The great mass of the stone is manufactured in this shape, all of the other forms of the stone requiring special adjustment of the saws. After sorting, the stones go to the rub wheel. Here the Arkansas stones get their final finish, but not so with the Ouachita stones. The water absorbed in the sawing and rubbing processes gives the latter a bluish or greenish color, which is considered objectionable, so the stones are dried, when they assume a pure white hue. After drying, the stone may be rubbed with pumice, the process being called cleaning. This restores the white color which may have become obscured from dirt filling the pores during the sawing and rubbing processes. The chief use of Ouachita stones is for whetstones for the coarser tools. The Arkansas stones are generally used to finish tools which have undergone a preliminary sharpening with a coarser stone.

CORUNDUM AND EMERY.

PRODUCTION.

The United States produced no corundum in 1911 and has produced none since 1906. The entry in the following table for 1911 is for emery which came from Chester, Hampden County, Mass., and from near Peekskill, Westchester County, N. Y. The domestic production of emery in 1911 amounted to $6,778 in value, or 2 per cent of the imports. This ratio between domestic production and imports is the same as that during 1910, but 1911 was marked by a notable reduction in the imports as well as in domestic production. The decline in production amounted to $8,299, or 55 per cent, in value and to 369 short tons, or 36 per cent, in quantity. The value of the material per ton was $10.29, compared with $14.67 in the preceding year. The figures of value given above represent the material as shipped from the mines, where it undergoes a rough sorting or cobbing.

In the following table are given the quantity and value of the emery produced in the United States since 1906, the figures for the preceding years including the value of corundum:

Annual production of corundum[1] and emery, 1881–1911, in short tons.

Year.	Quantity.	Value.	Year.	Quantity.	Value.
1881	500	$80,000	1897	2,165	$106,574
1882	500	80,000	1898	4,064	275,064
1883	550	100,000	1899	4,900	150,600
1884	600	108,000	1900	4,305	102,715
1885	600	108,000	1901	4,305	146,040
1886	645	116,190	1902	4,251	104,605
1887	600	108,000	1903	2,542	64,102
1888	589	91,620	1904	1,916	56,985
1889	2,245	105,567	1905	2,126	61,464
1890	1,970	89,395	1906	1,160	44,310
1891	2,247	90,230	1907	1,069	12,294
1892	1,771	181,300	1908	669	8,745
1893	1,713	142,325	1909	1,580	18,185
1894	1,495	95,936	1910	1,028	15,077
1895	2,102	106,256	1911	659	6,778
1896	2,120	113,246			

[1] No production of corundum since 1906.

IMPORTS.

The following table gives the quantity and value of the emery and corundum imported into the United States from all foreign countries during the last five years. The year 1911 was marked by a falling off in the importations as compared with the preceding year, but the figures are comparable with those of the year 1909. The excess in imports for 1910 as compared with those for 1909 and 1911 seems abnormal, and the falling off shown for 1911 seems to indicate that the importation for 1910 was in excess of the trade demands. The decline in imports was in both grain emery and in crude ore and rock; the value of manufactured emery or corundum increased slightly.

Emery and corundum imported into the United States, 1907–1911.

Year.	Grains.		Ore and rock.		Other manufactures.	Total value.
	Quantity.	Value.	Quantity.	Value.	Value.	
	Pounds.		*Long tons.*			
1907	4,282,228	$186,156	11,235	$211,192	$15,282	$412,630
1908	1,735,366	89,702	8,084	146,105	12,592	248,399
1909	2,696,960	132,264	9,836	186,930	19,803	338,997
1910	2,311,464	106,570	28,948	509,661	13,527	629,758
1911	1,382,813	76,027	10,822	245,459	15,158	336,644

GRECIAN EMERY.

The emery deposits of the Grecian Archipelago are associated with massive limestones and dolomites which constitute the principal islands. Three workable zones are distinguishable, the lowermost of which is the most productive and is the one operated at Naxos. Here the ore occurs in the form of interstratified lenses, some of which average 10 meters in thickness and are traceable for a distance of a kilometer.

Naxos emery is very pure. It occurs in a compact granulated mass mingled with magnetite and some hematite. The impure varieties display a banded structure and are associated with tourmaline, margarite, muscovite, and calcite. Gray veins of corundum, sapphire, quartz, and sillimanite are also rarely present. The emery is thought to have originated from the influence of massive dikes of pegmatite, which in turn are related to intrusions of granite.

The emery deposits of the two upper zones, developed only on Iraklia and Sikinos, are similar in character, but are more finely granulated and are associated with more finely crystallized limestones. That of the highest zone is contaminated by a larger percentage of iron oxide, and also contains margarite and chlorite. Many of these inferior deposits would be commercially valuable, but the Grecian Government imposes an export tax on all private enterprises in order to maintain its monopoly of the superior grades mined in Naxos.[1]

CANADIAN CORUNDUM.[2]

For years the production of corundum in Canada has come from the Manufacturers' Corundum Co., formerly the Canada Corundum Co., at Craigmont, and the Ashland Emery & Corundum Co., at Burgess mines. The Ashland Co.'s mines and works were leased by the Manufacturers' Co. in August, 1910, which consequently makes the latter company the sole producer of Canadian corundum. The Manufacturers' Corundum Co. is also working the Armstrong property.

All the corundum is mined by open-cut methods on account of the limited depth to which it has so far been found. Corundum has been taken from the hill at the Craig mine over a surface area of 25 to 40 acres. This hill is still furnishing most of the ore for the mill. Some ore is also obtained from the workings known as the Klondike on the west end of the hill.

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[1] Eng. and Min. Jour., Dec. 16, 1911, p. 1180.

[2] Twentieth Ann. Rept. Ontario Bur. Mines, pt. 1, 1911, pp. 43, 112.

The quantity taken out and shipped from both mines in 1910 was 1,870 short tons of grain corundum, valued at $198,680, or about 5.31 cents per pound. There were 201 men employed at the mines and works, who received in wages the sum of $100,945. The production in 1911 amounted to 1,472 short tons, valued at $161,873, or 5½ cents a pound.[1]

The following table gives the quantity and value of Canadian corundum shipped during the last five years:

Shipments of Canadian corundum, 1907–1911, in short tons.

Year.	Quantity.	Value.	Year.	Quantity.	Value.
1907	1,892	$177,922	1910	1,870	$198,680
1908	1,089	100,398	1911	1,472	161,873
1909	1,491	162,492			

ABRASIVE GARNET.

PRODUCTION.

The production of abrasive garnet in 1911 amounted to 4,076 short tons, valued at $121,748. This was an increase of 262 tons in quantity and of $8,174 in value as compared with 1910. The industry was confined, as usual, to three States—New York, New Hampshire, and North Carolina. The statistics of production in the abrasive garnet industry are given below:

Production of abrasive garnet, 1895–1911, in short tons.

Year.	Quantity.	Value.	Year.	Quantity.	Value.
1895	3,325	$95,050	1904	3,854	$117,581
1896	2,686	68,877	1905	5,050	148,095
1897	2,554	80,853	1906	4,650	157,000
1898	2,967	86,850	1907	7,058	211,680
1899	2,765	98,325	1908	1,996	64,620
1900	3,185	123,475	1909	2,972	102,315
1901	4,444	158,100	1910	3,814	113,574
1902	3,926	132,820	1911	4,076	121,748
1903	3,950	132,500			

GARNET MILLING IN NEW HAMPSHIRE.[2]

Garnet is associated with a granitic rock which outcrops near the top of Currier Hill in North Wilmot, Merrimac County, N. H. The outcrops extend over an area covering approximately an acre. About 40 to 50 per cent of the rock consists of garnet crystals not very well developed. The associated minerals are quartz, feldspar, and biotite.

The garnet crystals are about one-quarter inch in diameter, have a somewhat rounded appearance, and contain included quartz and biotite. The last condition makes fine crushing necessary to insure a clean separation. After the garnet has been crushed and cleaned the fractures appear sharp and are well adapted for use in garnet paper.

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[1] Prelim. Rept. Min. Prod. Canada during 1911; Canada Dept. Mines, 1912, pp. 7, 23.

[2] Bardwell, E. S., Garnet milling in New Hampshire: Eng. and Min. Jour., June 17, 1911, pp. 1209–1210.

The rock is quarried and afterwards broken by sledges into pieces convenient for feeding to the breaker. The broken rock is trammed a distance of about 600 feet to the rock house, which is located at the brow of a steep cliff. The cars run from the quarry by gravity, the last 100 feet being over a trestle with a slight upgrade sufficient to check their momentum. Directly beneath the floor upon which the rock is dumped is a 6 by 10 inch Sturtevant jaw breaker, crushing to 1¼ inches. This breaker makes 165 thrusts per minute, has a capacity of 6 tons per hour, and requires 7 horsepower, which is furnished by a 15-horsepower 3-phase 60-cycle 220-volt General Electric induction motor, making 1,200 revolutions per minute. The broken rock falls from the breaker directly into the tramway loading bin beneath.

The aerial tramway * * * is constructed in a single span 1,200 feet in length and delivers the rock to the mill bin, the elevation of which is 225 feet lower than that of the loading terminal. This is of the 2-bucket type and has a capacity of 30 tons hourly. No power other than that of gravity is required. The time of one man for about one hour daily is all that is required to keep the mill supplied.

The mill is a wooden structure covering an area of 50 by 36 feet, situated at the foot of the Currier hill about 200 feet from the main road. It is a two and one-half story building with a screening tower 12 feet square near the front and rising above the roof. This tower has two floors above the third floor of the mill.

The crushed rock is delivered by way of the aerial tram into a bin at the rear of the mill, 14 feet square, with bottom sloping at an angle of 45°. The top of the bin is on a level with the third floor of the mill. The rock is delivered by gravity to the crushing department.

The ore first enters a pair of Sturtevant balanced rolls, 26 by 15 inches, making 82 revolutions per minute, and capable of crushing 6 tons per hour to ⅜-inch. The rolls are on the first-floor level and rest upon a solid concrete foundation. From these rolls the product is taken by a bucket elevator, 16 feet between centers. The 8-inch 6-ply rubber belt has 6 by 4 inch malleable-iron buckets, spaced 18 inches apart. The belt runs at 300 feet per minute, and delivers the crushed rock to an American Process Co. drier. The revolving cylinder is 21 feet in length and makes 17 revolutions per minute and is driven through a sprocket chain. Soft coal is used as fuel, but little fire is needed, as the rock is ordinarily fairly dry. It is warmed to remove any superficial moisture and to prevent screening.

The revolving cylinder of the drier projects into a reenforced-concrete dust chamber which extends through the side of the mill. This chamber is 12 by 12 by 12 feet in outside dimensions, with roof and sides 10 inches thick. The roof is flat and is reenforced with ⅝-inch twisted steel rods spaced 4½ inches on centers. The rods were 14 feet in length originally, but were bent at each end so as to give them an 18-inch bearing in the side walls. The dust chamber supports the 24-inch steel stack, 50 feet in height. The drier delivers the sands through a chute in the side wall of the dust chamber to another bucket elevator, while the dust which settles in the dust chamber is removed from time to time through the cleaning door outside the mill. The dust is discarded for the reason that it contains almost no garnet.

The second elevator delivers the sand to a No. 3 Newaygo separating screen making 90 revolutions per minute. The screen cloth is 4 mesh, 14 wire, and is set on a slope of about 45°. The oversize (over 2 millimeters) goes by chute to a pair of Sturtevant balanced rolls, 26 by 15 inches, set to crush to 2 millimeters and making 100 revolutions per minute, the product going with the undersize to the separator bin, from which material under 2 millimeters is delivered to the separating department by a belt elevator.

The crushing department is run by a 50-horsepower, 3-phase, 60-cycle, 220-volt General Electric induction motor making 1,200 revolutions per minute. The crushing department may be run independently or may be closed down at any time without interfering with the operation of the rest of the mill. It is usually run about four hours per day, and during this time is capable of crushing enough rock to keep the separating department supplied during the entire 10-hour run.

The crushed material first passes through a No. 3 Newaygo separating screen. This screen is situated upon the upper floor of the screening tower and has two sieves; the upper screen is 6 mesh, 16 wire, and the lower is 10 mesh, 20 wire. This screen makes two oversize products—that is, through 2 millimeters on 1.4 millimeters and through 1.4 millimeters on 0.75 millimeter. These products go by way of chutes to table bins on the third floor of the mill. The undersize of 0.75 millimeter goes to another Newaygo screen on the floor below. This separator has one sieve, 24 mesh, 29 wire. Two products are made, 0.36 to 0.75 millimeter and under 0.36. The 0.36 to 0.75 millimeter size goes to a third table bin, and the under 0.36 millimeter size goes to waste.

The material from 1.4 to 2 millimeters in diameter goes to a Sutton, Steele & Steele dry-concentrating table. This table makes 390 thrusts per minute, has a capacity of about 3,000 pounds per hour, and requires approximately one-half horsepower. It delivers garnet through a spout to the sacking room in the basement of the mill, middlings to the second Newaygo screen, and tailings by screw conveyor out of the mill. Air is supplied to the table by a No. 10 Green blower making 500 revolutions per minute and belted to the line shaft. The material from 0.75 to 1.4 millimeters in diameter from the first Newaygo, and that from 0.36 to 0.75 millimeter in diameter from the second Newaygo are treated alternately on a second Sutton, Steele & Steele dry-concentrating table. This table makes 425 thrusts per minute, has a capacity of about 1,500 pounds per hour, and requires approximately one-half horsepower. The delivery of products is the same as from the first table. Air is furnished to this table by a No. 6 Green blower making 965 revolutions per minute.

The tailings from these tables are practically free from garnet but contain about 25 per cent of biotite. A Wetherill magnetic separator has been provided to save this biotite, but so far nothing has been done with the product. The separating plant is run by a 15-horsepower 3-phase 60-cycle 220-volt General Electric induction motor making 1,200 revolutions per minute.

The sacking room is in the basement of the mill. The garnet is shipped in canvas sacks each containing 100 pounds. The company has a freight house at South Danbury, N. H., 3 miles distant, with capacity for storing 400 tons. Here the garnet is loaded directly into the cars. The plant is at the present time producing garnet at the rate of 12 tons in 10 hours.

The power plant is situated about 1¼ miles from the mill at a point where there is a plentiful supply of water for boiler purposes. The equipment consists of a 120-horsepower Hodge locomotive-type boiler supplying steam at 100 pounds pressure to an 80-horsepower simple noncondensing high-speed American Ball engine direct connected to a 75-kilovolt-ampere 3-phase 60-cycle 2,300-volt General Electric alternater. The transformers for the motors at the mill and at the quarry are placed outside the mill in a separate building.

There is a machine shop on the first floor of the mill building. This shop is equipped with a Fay & Scott engine lathe, emery grinders, drill press, and all tools necessary for repairs about the plant. The machine shop is so arranged that it may be operated by a gasoline engine at times when the power plant is not in operation.

INFUSORIAL EARTH AND TRIPOLI.

PRODUCTION.

Infusorial earth and tripoli were produced in 1911 in the following States: California, Connecticut, Illinois, Maryland, Massachusetts, Missouri, Nevada, New York, and Virginia. By the term "tripoli" is meant a light porous siliceous rock, supposed to have resulted from the leaching of calcareous material from a siliceous limestone. Diatomaceous earth is entirely different in its origin. It is largely made up of silica, is a variety of opal, and represents the remains of certain aquatic forms of plant life known as diatoms. The output of tripoli came from Illinois and Missouri, and diatomaceous or infusorial earth came from the other States mentioned. The reasons for combining the figures of production of these two commodities have been outlined in former reports on abrasives and therefore will not again b detailed here.

The value of the production for the year 1911 was $147,462 an exceeded by $17,456 the value for 1910. The value of the tripoli o Illinois and Missouri constitutes the great bulk of the figure given above. It must be recalled, however, in this connection, that large part of the tripoli produced in the United States is used fo other than abrasive purposes. Missouri tripoli is used, for example, to a certain extent, in the manufacture of filter stones, and th Illinois product is sized by screening or floating and used as a woo filler, wood polisher, and probably for other purposes. The Illino field was visited in the fall of 1911, and notes were made on th occurrence of the deposits as well as on the methods of mining th tripoli and preparing it for market. It has been thought well to defer the publication of the results of these observations until the subject can be studied and worked out in greater detail and also until the Missouri field can be visited and a comparative study made of the deposits in the two States.

In the following table is given the value of the production of nfusorial earth and tripoli from 1880 to 1911, inclusive:

Production of infusorial earth and tripoli, 1880–1911, in short tons.

Year.	Quantity.	Value.	Year.	Quantity.	Value.
1880	1,833	$45,660	1896	3,846	$26,792
1881	1,000	10,000	1897	3,833	22,835
1882	1,000	8,000	1898	2,733	16,691
1883	1,000	5,000	1899	4,334	37,032
1884	1,000	5,000	1900	3,615	24,207
1885	1,000	5,000	1901	4,020	52,950
1886	1,200	6,000	1902	5,665	53,244
1887	3,000	15,000	1903	9,219	76,273
1888	1,500	7,500	1904	6,274	44,164
1889	3,466	23,372	1905	10,977	64,037
1890	2,532	50,240	1906	8,099	72,108
1891		21,988	1907		104,406
1892		43,655	1908		97,442
1893		22,582	1909		122,348
1894	2,584	11,718	1910		130,006
1895	4,954	20,514	1911		147,462

TRIPOLI IN MISSOURI.

It is reported that a very large deposit of tripoli has been discovered near the big spring at Stella, Mo., about 25 miles east of Seneca. M. H. Thornberry, of the experiment station of the school of mines and metallurgy of the University of Missouri, located at Rolla, states in a personal letter that the deposit is within a few feet of the surface and appears to be thick enough to make its extraction profitable.

The material has all the characteristics of the Seneca tripoli. An analysis of a fair sample of the material shows the following composition:

Analysis of tripoli from Stella, Mo.

Silica (SiO_2)	97.86
Ferric oxide (Fe_2O_3)	.22
Alumina (Al_2O_3)	.37
Water (H_2O)	1.55
	100.00

DIATOMACEOUS EARTH IN VIRGINIA.[1]

Diatomaceous earth occurs in the Calvert formation of the Chesapeake group in the vicinity of Richmond, Va. The lower beds of the formation, chiefly those between 5 and 20 feet from the base, contain diatom remains in variable proportions to an extent sufficient to entitle it to be termed diatomaceous earth. On weathering the portions rich in diatom remains become nearly pure white.

The richer deposits occur mostly in streaks and irregular masses, grading into clay that contains a greatly diminished proportion. The deposits are irregular in form, and the amount of high-grade material available is not so large as in some other localities in Virginia and Maryland. The purer deposits are soft claylike material, which is very porous when dry, is white or slightly yellow in tint, and is of very light weight. When quite free from moisture a pure specimen has a specific gravity of only 0.33, or one-third the weight of water, bulk for bulk.

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[1] Darton, N. H., Economic geology of Richmond, Va., and vicinity: Bull. U. S. Geol. Survey No. 483, 911, pp. 26–44 and 45.

The diatom deposits about Richmond have never been worked. Two samples collected in Richmond have been tested by Ries as to their suitability in the manufacture of brick and other wares. They were collected from Seventh Street, near the locomotive works. Sample A was of weathered material and contained but few diatoms; sample B was from a point deeper in the bank. The weathered material was the more siliceous, and contained a small amount of fine particles and soluble substances probably due to the action of water on the exposed surface. The analyses of this material which, strictly speaking, had better be called diatom-bearing clay rather than true diatomaceous earth, are as follows:

Analysis of clay of Calvert formation at Richmond, Va.

[Made at Virginia Polytechnic Institute.]

	A	B
Silica (SiO_2)	70.42	63.17
Alumina (Al_2O_3)	15.15	19.30
Iron oxide (Fe_2O_3)	5.17	6.32
Lime (CaO)	.14	.06
Magnesia (MgO)	.79	.69
Potash (K_2O)	2.24	2.45
Soda (Na_2O)	.39	.69
Titanic oxide (TiO_2)	.44	.88
Loss in ignition (H_2O, etc.)	5.21	6.39
	99.95	99.95

Several analyses of diatomaceous earth in possession of the writer contain 80 per cent and more of silica, which, with the water present, both free and combined, constitutes approximately 90 per cent of the composition of the material. The remaining percentage is made up of alumina, ferric oxide, lime, magnesia, the oxides of potassium and sodium, and titanium oxide.

The fire tests of Ries gave the following results:

Fire tests of diatom deposits from Richmond, Va.

	1,720° F., cone 010.	1,922° F., cone 05.	1,994° F., cone 03.	2,102° F., cone 1.	2,174° F., cone 3.	2,240° F., cone 5.	2,354° F., cone 8.
Sample A:							
Fire shrinkage	0.6	0.6	2.0	3.0	3.3	5.0	2.0
Color	Light red.	Light red.	Light red.	Light brown.	Red brown.	Red gray.	Brown.
Absorption	14.6	13.6	12.4	9.1	6.9	5.0	2.0
Sample B:							
Fire shrinkage	6.0	2.3	3.3	5.0	6.0	6.0	5.5
Color	Light red.	Light red.	Light red.	Medium red.	Medium red.	Red gray.	Red gray.
Absorption	14.9	10.9	9.0	4.2	2.3	1.7	1.1

IMPORTS.

The imports of infusorial earth and tripoli into the United States are not separately recorded by the Department of Commerce and Labor, but are included with rottenstone used for similar purposes.

The value of the imports of rottenstone and of tripoli for the last five years has been as follows: 1907, $27,121; 1908, $17,252; 1909, $24,024; 1910, $56,657; and 1911, $35,665. No record is kept of the number of tons of this material imported.

PUMICE.

The pumice produced in the United States in 1911 amounted to 21,689 short tons, valued at $88,399. This was a decrease of 1,582 short tons in quantity and of $6,544 in value, as compared with 1910. One of the reasons for the slight falling off is that large stocks were purchased in 1910 for use in 1911, which was not the case in 1911 for 1912; hence the production for 1911 may be considered nearly normal. The increases both in production and in value in 1910 were very large as compared with those of 1909. (See table below.)

The statistics of pumice given in the table are those of pumice used for abrasive purposes solely. The pumice used for construction—and it is known that some of the domestic article is so used—is not included. The material comes from only two States: Kansas, from Phillips County; and Nebraska, from Furnas, Lincoln, and Harlan counties. The business for 1911 was reported good, and as the merits of the domestic product become more generally known there is no reason why it should not gradually replace the foreign product.

The production of the United States during the last five years is given in the following table. It shows a gradual but strong growth with an upward tendency in the value of the product. The value of the domestic product, though approaching, has not yet reached that of the imported article. The figures for both domestic production and importation are given below:

Production of pumice in the United States, 1906–1911, in short tons.

Years.	Quantity.	Value.	Price per ton.
1906	12,200	$16,750	$1.37
1907	8,112	33,818	4.17
1908	10,569	39,287	3.72
1909	15,103	33,439	2.21
1910	23,271	94,943	4.08
1911	21,689	88,399	4.08

Value of pumice imported for consumption into the United States, 1907–1911.

1907	$85,647
1908	67,094
1909	100,997
1910	$104,425
1911	118,977

ARTIFICIAL ABRASIVES.

The artificial abrasives include carborundum, alundum, and crushed steel. Other abrasives, or rather abrasives with other names, which have appeared on the market during the last few years, are forms of the abrasives named adapted to special uses. Such, for example, are aloxite and samite, forms of carborundum, and carborundum fire sand. The abrasive known as "corubin," so far as is known, is not made in this country, but is an European product. The abrasive, alundum, whose manufacture has been detailed in this chapter in previous years, is finding extended use in the refractory as well as in the abrasive industry. L. E. Saunders,[1] of the Norton Co., has recently presented data on the value of alundum in the refractory industries, to which its property of resistance to heat as well as its other properties particularly adapt it. Two forms of alundum are of interest in this connection—a white crystalline product with less than 1 per cent of impurities and a reddish-brown vitreous product with 6 to 8 per cent of impurities, which consist of oxides of iron, titanium, and silicon. The purer white product melts between 2,050° and 2,100° C., the brown product at not more than 50° lower. The coefficient of expansion is low. The thermal conductivity is from three to four times that of most fire clay. The hardness of the material is about 9 in Moh's scale. Both the white and the colored varieties are unattacked by aqueous acids and alkalies and only very superficially by fused carbonates. Basic and acidic slags dissolve them with some difficulty, acidic slags having a readier action.

The easiest method of preparing the different articles consists in mixing the crushed grains with a binding agent of a refractory and ceramic nature, molding the desired pieces after the manner of the potter and burning them in a kiln. Some attempts have been made to mold the shapes from the liquid material, but they have met with only partial success.

The articles thus far turned out are mostly porous, consisting of more or less finely divided grains held together by a ceramic bond. This porosity renders them unfit for any work in which a gas-tight chamber is required, but, on the other hand, is very advantageous in another way, for the porosity can be varied to such a degree that crucibles and dishes may be made for filtering purposes. The Gooch type of crucibles or filtering dishes, for example, made of this material serve perfectly in analytical work. They save time in the laboratory, and as they are unattacked by acid or alkali they may be used in most analytical processes. Other articles which have been made are mufflers of many shapes and sizes, combustion boats, extraction thimbles, filter tubes, filter dishes, electrical furnace sections and parts, corrugated furnace cores, arc-lamp economizers, tubes, etc. Alundum bricks have been made experimentally, but their high cost of manufacture and their great weight make them available only in special cases. They are well adapted to the roofs of electric furnaces on account of their high melting point and low coefficient of expansion.

The production of artificial abrasives since 1907 is given in the following table:

Production of artificial abrasives in the United States, 1906–1911, in pounds.

Year.	Quantity.	Value.
1906	11,774,300	$777,081
1907	14,632,000	1,027,246
1908	8,698,000	626,340
1909	20,468,000	1,365,820
1910	23,027,000	1,604,030
1911	21,292,000	1,493,040

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[1] Met. and Chem. Eng., April, 1911, p. 225; May, 1911, p. 257.

ARSENIC.

By Frank L. Hess.

In the four years ending with 1911 the only white arsenic (As_2O_3) produced in the United States was that made as a by-product in smelting plants. The United States Smelting Co., the American Smelting & Refining Co., and the Anaconda Copper Mining Co. produced an aggregate of 3,132 tons of white arsenic during the year 1911, valued at $73,408, an average of 1.1719 cents a pound, varying from 0.8695 cent to 1.695 cents a pound f. o. b. at the smelter.

The output is much the largest so far made in this country, and the prices during the year were the lowest. The smelters are all far from the New York market, and when prices are so low freight rates absorb a large proportion of the returns.

The production and importation of white arsenic, arsenic, and arsenic sulphides and of Paris green and London purple since 1902 are given in the following table:

Production and imports of arsenic, 1902–1911.

Year.	Production of white arsenic.		Imports.[a]			
			White arsenic, metallic arsenic, and arsenic sulphides.		Paris green and London purple.	
	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (pounds).	Value.
1902	1,353	$81,180	4,055	$280,055	....	....
1903	611	36,691	4,179	294,602	....	....
1904	36	2,185	3,400	243,380	28,498	$985
1905	754	35,210	3,838	256,540	44,931	1,118
1906	737	63,460	3,987	350,045	311,293	21,347
1907	1,751	163,000	5,164	574,998	133,422	21,919
1908	(b)	....	4,964	430,400	195,000	30,764
1909	1,214	52,946	4,036	303,728	183,765	20,370
1910	1,497	52,305	5,139	314,306	181,363	14,648
1911	3,132	73,408	4,096	247,323	126,191	4,972

[a] Figures furnished by the Bureau of Statistics.

[b] There were only two producers of arsenic in the United States in 1908, so that the figures of production may not be given.

The white arsenic imported amounted to 1,921 tons, an increase of nearly 600 tons over the imports of 1910, and this was in the face of an increase of more than 1,600 tons in the domestic production. The value given for the imported arsenic was $116,948, more than 3 cents a pound. As in previous years, the value given by the importer is higher than the market value and evidently represented what the seller wished to get rather than what he expected.

As quoted by the Oil, Paint, and Drug Reporter, the price of white arsenic on the New York market at the beginning of the year was about 2¼ cents a pound in large lots. The price gradually fell until the middle of June, when it reached 1½ cents a pound, the lowest price recorded. Prices then gradually rose until the end of the year, when they reached 2½ cents a pound, the highest price of the year.

Concerning the prices of Paris green, the same paper says:[1]

> Paris green moved freely as soon as prices were established in April. These prices were lower than those established in 1909 [1910] and were as follows: For quantities of 10,000 pounds or over, arsenic kegs, 13 cents per pound; 100 to 175 pound kegs, 13½ cents per pound; 14, 28, and 56 pound kits, 14½ cents per pound; and 5-pound boxes, 15 cents per pound; 1-pound boxes, 16 cents per pound; ½-pound boxes, 17 cents per pound; ¼-pound boxes, 18 cents per pound; in quantities from 5,000 to 10,000 pounds, ½ cent per pound advance; in quantities of 1,000 to 5,000 pounds, 1½ cents per pound advance; in quantities of 500 to 1,000 pounds, 2½ cents per pound advance; in quantities of less than 500 pounds, 3½ cents per pound advance. This market was featured by another change late in the year when prices for 1912 were established on a new and lower basis, which is as follows: Arsenic, kegs, 11 cents; 100 to 175 pound kegs, 11½ cents; 14, 28, and 56 pound kits, 12½ cents; 2 and 5 pound boxes, 13 cents; 1-pound boxes, 14 cents; ½-pound boxes, 15 cents; ¼-pound boxes, 16 cents.

Orpiment remained throughout the year at about 6¼ cents per pound, the price depending on quantity and seller.

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[1] Oil, Paint, and Drug Reporter, vol. 81, No. 9, pt. 2, Feb. 26, 1912, p. 50.

BORAX.

By Charles G. Yale and Hoyt S. Gale.

GENERAL CONDITIONS.

In 1911 the production of borax in the United States was 53,330 short tons, valued at $1,569,151, as compared with 42,357 tons in 1910, valued at $1,201,842. The quantity stated is the crude material mined, and the value is fixed in accordance with the percentage of anhydrous boric acid in the ore. The crude ore now being mined in California is almost entirely colemanite, which is a borate of lime, and as mined the product varies considerably in its content of anhydrous boric acid, due to the amount of impurity contained with the borate mineral in the ore. This variation holds true not only in different mines but in different parts of the same mine, so that it is necessary to determine the percentage of this acid in the ore in order to fix the value of the output.

The price of refined borax ranged from 3½ to 4 cents per pound during the year 1911. There was no marked difference in either the demand or supply of borax or boric acid for the year as compared with that of recent years. California continues to yield the entire production in this country, and this is derived principally from two mines, although a smaller production is reported from a third locality, and some reports have been received announcing the opening up of other deposits.

In view of the fact that virtually the entire product of borax in the United States continues to be derived from two mines in California, one in Inyo County and the other in Los Angeles County, it is impracticable to give much of a review of the mining conditions. In fact, there is little to record, there having been no changes of moment during the year 1911. The ore now handled is all colemanite. Most of the old mines of the State, which were closed in 1907 at the time of the sudden drop in the price of borax, still remain idle, with little prospect of starting up again, for the present at least. Many of the abandoned properties had mined low-grade "marsh" material, which no longer pays. Since the colemanite mines have been worked on a large scale, the marsh or dry-lake deposits have been neglected. Borax, instead of being crystallized from the mixtures of other salts from the marsh deposits, is now made exclusively in the refineries of the large borax companies in California and at eastern points.

DEVELOPMENT OF BORAX INDUSTRY.

The history of the development of the borax industry in the United States has been reviewed in a number of publications, notably in the earlier volumes of this series,[1] and also in the Third Annual Report and in Bulletin 24 of the California State Mining Bureau. Descriptions of the various types of deposits that have from time to time been worked in this country are also to be found in the literature of this subject, including more or less of the technology describing the modifications that have been necessitated in processes of reduction, as the supply has been derived first from one class of deposits and then from another. These subjects are therefore treated here only in briefest outline, and the reader is referred to the bibliography at the end of this chapter for more complete data.

Borax Lake and Lake Hachinhama, two small lakes near Clear Lake, in California, about 80 miles north of San Francisco, first produced borax on a commercial scale in 1864. Borax was discovered in these waters by Dr. John A. Veatch in 1859. At first borax was obtained by evaporation of the lake water, but this was later supplemented by the collection and washing of natural borax crystals which were found imbedded in the mud on the bottom of the lake. The lake water is reported to have contained 7.66 per cent of salts in solution, and an anhydrous boric acid equivalent of a little over 5 per cent of these salts.

The second stage in the development of borax production followed the discovery of the so-called marsh or dry-lake borax deposits, a considerable number of which were developed in western Nevada. Fish Lake, Columbus, Rhodes, and Teals marshes in southwestern Nevada near the California line, Searles Dry Lake, Cane Lake, Saline Valley, and Death Valley in California were among the more important localities containing deposits of this type from which active production was established. In these deposits the borax occurs as a thin saline crust on the surface of the marsh, the most characteristic portion of which is the "cotton-ball" or soft fibrous tufts of the mineral ulexite. Such deposits are generally associated with other salts, from which the borax has to be separated or refined. Many of these marshes were remotely situated at the time the borax was shipped from them, and the product was customarily transported by horse or mule teams over long desert hauls to the railroad. Salt Wells Flat, near Fallon, Nev., was also worked for its borax for a while. A marsh deposit near Lake Alvord, in Harney County, Oreg., is reported to have been successfully worked as late as 1901. Similar deposits also occur near Warner Lake, in Lake County, Oreg., and at other localities. Some other deposits of this type were operated in a small way at this time, including a small plant established at the Hot Springs, near the present site of the town of Gerlach, in Washoe County, Nev., when this place was still some hundred miles, more or less, from its nearest railroad shipping point. Unsuccessful attempts were made to work the waters of the Soda Lakes (Ragtown Ponds), near Fallon, Nev., for borax, and the Hot Springs near Humboldt, on the old route of the Central Pacific Railroad east of Wadsworth, Nev.

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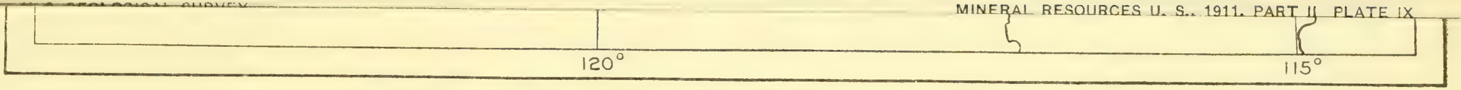
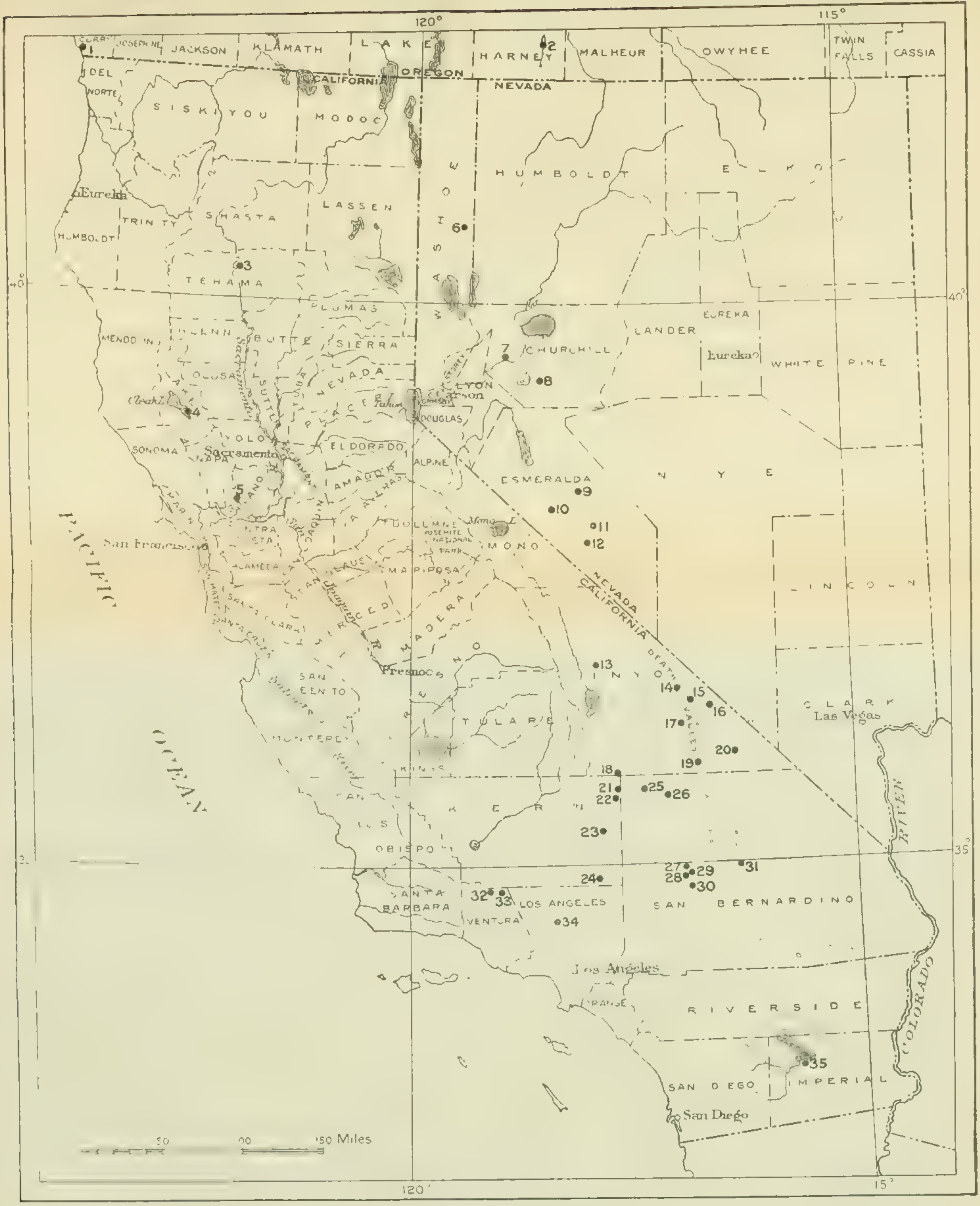
[1] Mineral Resources U. S. for 1882, pp. 566-577; for 1883-84, pp. 859-863; for 1889-90, pp. 494-506; and subsequent volumes.



MAP SHOWING BORAX DEPOSITS IN THE UNITED STATES.

[Based on data furnished chiefly by Gilbert E. Bailey.]

1. Chetco, Curry County, Oreg. Priceite was mined.
2. Marsh deposits near Lake Alvord, Harney County, Oreg.
3. Tuscan Springs, Tehama County, Cal. First discovery of borated waters by Veatch.
4. Clear Lake, Lake County, Cal. First workings in California.
5. Solano beds, Fairfield, Solano County, Cal.
6. Hot Springs waters at Gerlach, Washoe County, Nev. Borax plant established at one time.
7. Soda Lakes (Ragtown Ponds), near Fallon, Churchill County, Nev.
8. Salt Wells, Churchill County, Nev. Old marsh borax plant.
9. Rhodes Marsh, Esmeralda County, Nev. Former large workings.
10. Teals Marsh, Esmeralda County, Nev. Former large workings.
11. Columbus Marsh, Esmeralda County, Nev. Former large workings.
12. Fish Lake Valley, Esmeralda County, Nev. Marsh deposits; former large workings.
13. Saline Valley, Inyo County, Cal. Marsh deposits; former workings.
14. Coleman (Furnace Creek ranch), Inyo County, Cal. Main works of the 20-mule teams, 1883.
15. Mount Blanco, Inyo County, Cal. Large undeveloped deposits of colemanite.
16. Lila C. mine, Ryan, Inyo County, Cal. Colemanite. Property of Pacific Coast Borax Co.; largest producer.
17. Slate Range, Inyo County, Cal. Colemanite reported.
18. El Paso Peak, Inyo County, Cal. Colemanite reported.
19. South end of Death Valley, Inyo County, Cal. Colemanite reported.
20. Resting Springs, Zabriskie, Inyo County, Cal. Worked in 1883.
21. China Lake (Mesquite Springs), Kern County, Cal. Worked in 1883.
22. Colemanite reported.
23. Cane Lake, Kern County, Cal. Marsh deposits formerly worked.
24. Rodriguez Lake, Kern County, Cal. Borax locations; never produced.
25. Searles Lake, San Bernardino County, Cal. Marsh deposits formerly worked.
26. Slate Range, San Bernardino County, Cal. Colemanite reported.
27. Town of Borate, San Bernardino County, Cal. Formerly principal works of Pacific Coast Borax Co.
28. American Borate Co.'s works, San Bernardino County, Cal. Recently abandoned.
29. Palms Borate Co.'s mine and plant, San Bernardino County, Cal. Closed down.
30. Property of Palms Borate Co., San Bernardino County, Cal.
31. Mohave Canyon borax mine, San Bernardino County, Cal.
32. Piru mines, Ventura County, Cal. Stauffer Chemical Co.; colemanite deposits.
33. Frazier Mountain borax mines, Ventura County, Cal. Colemanite.
34. Lang, Los Angeles County, Cal. Sterling Borax Co.; colemanite; large producer.
35. Mud Volcanoes, Imperial County, Cal. Borax present in waters.


120°
115°
CURRY
JOSEPHINE
JACKSON
KLAMATH
LAKE
HARNEY
MALHEUR
OWYHEE
TWIN FALLS
CASSIA
OREGON
CALIFORNIA
NEVADA
DEL NORTE
SISKIYOU
MODOC
HUMBOLDT
ELKO
Eureka
LASSEN
TRINITY
SHASTA
WASHOE
TEHAMA
PLUMAS
GLENN
BUTTE
SIERRA
CHURCHILL
LANDER
EUREKA
WHITE PINE
MENDOCINO
COLUSA
NEVADA
LYON
Carson
DOUGLAS
Clear L.
YOLO
PLACER
SUTTER
EL DORADO
SONOMA
NAPA
Sacramento
ALPINE
AMADOR
CALAVERAS
ESMERALDA
NYE
SOLANO
TUOLUMNE
YOSEMITE NATIONAL PARK
Mono L.
MONO
San Francisco
CONTRA COSTA
ALAMEDA
STANISLAUS
MARIPOSA
MERCED
MADERA
SANTA CLARA
SAN MATEO
SANTA CRUZ
PACIFIC
LINCOLN
NEVADA
CALIFORNIA
DEATH VALLEY
INYO
SAN BENITO
Fresno
FRESNO
CLARK
Las Vegas
MONTEREY
TULARE
KINGS
OCEAN
SAN LUIS OBISPO
KERN
RIVER
SANTA BARBARA
VENTURA
LOS ANGELES
SAN BERNARDINO
Los Angeles
ORANGE
RIVERSIDE
COLORADO
SAN DIEGO
IMPERIAL
San Diego
1
2
3
4
5
6
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10
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34
35
40°
35°
50
100
150 Miles

MAP SHOWING BORAX DEPOSITS IN THE UNITED STATES.

[Based on data furnished chiefly by Gilbert E. Bailey.]

1. Chetco, Curry County, Oreg. Priceite was mined.
2. Marsh deposits near Lake Alvord, Harney County, Oreg.
3. Tuscan Springs, Tehama County, Cal. First discovery of borated waters by Veatch.
4. Clear Lake, Lake County, Cal. First workings in California.
5. Solano beds, Fairfield, Solano County, Cal.
6. Hot Springs waters at Gerlach, Washoe County, Nev. Borax plant established at one time.
7. Soda Lakes (Ragtown Ponds), near Fallon, Churchill County, Nev.
8. Salt Wells, Churchill County, Nev. Old marsh borax plant.
9. Rhodes Marsh, Esmeralda County, Nev. Former large workings.
10. Teals Marsh, Esmeralda County, Nev. Former large workings.
11. Columbus Marsh, Esmeralda County, Nev. Former large workings.
12. Fish Lake Valley, Esmeralda County, Nev. Marsh deposits, former large workings.
13. Saline Valley, Inyo County, Cal. Marsh deposits, former workings.
14. Coleman (Furnace Creek ranch), Inyo County, Cal. Main works of the 20-mule teams, 1883.
15. Mount Blanco, Inyo County, Cal. Large undeveloped deposits of colemanite.
16. Lila C. mine, Ryan, Inyo County, Cal. Colemanite. Property of Pacific Coast Borax Co., largest producer.
17. Slate Range, Inyo County, Cal. Colemanite reported.
18. El Paso Peak, Inyo County, Cal. Colemanite reported.
19. South end of Death Valley, Inyo County, Cal. Colemanite reported.
20. Resting Springs, Zabriskie, Inyo County, Cal. Worked in 1883.
21. China Lake (Mesquite Springs), Kern County, Cal. Worked in 1883.
22. Colemanite reported.
23. Cane Lake, Kern County, Cal. Marsh deposits formerly worked.
24. Rodriguez Lake, Kern County, Cal. Borax locations, never produced.
25. Searles Lake, San Bernardino County, Cal. Marsh deposits formerly worked.
26. Slate Range, San Bernardino County, Cal. Colemanite reported.
27. Town of Borate, San Bernardino County, Cal. Formerly principal works of Pacific Coast Borax Co.
28. American Borate Co.'s works, San Bernardino County, Cal. Recently abandoned.
29. Palms Borate Co.'s mine and plant, San Bernardino County, Cal. Closed down.
30. Property of Palms Borate Co., San Bernardino County, Cal.
31. Mohave Canyon borax mine, San Bernardino County, Cal.
32. Piru mines, Ventura County, Cal. Stauffer Chemical Co.; colemanite deposits.
33. Frazier Mountain borax mines, Ventura County, Cal. Colemanite.
34. Lang, Los Angeles County, Cal. Sterling Borax Co.: colemanite; large producer.
35. Mud Volcanoes, Imperial County, Cal. Borax present in waters.

Bedded mud or clay deposits north of Daggett, Cal., containing low-grade borates of lime, furnished a third and somewhat less important phase in the development of the borax industry. Extensive plants were erected in 1901 for the extraction of boric acid from these mud deposits, but they were forced to suspend operation with the increased development of the higher-grade colemanite ores.

The final stage in the establishment of the borax industry on essentially its present basis came with the recognition and development of the bedded deposits of the calcium borate mineral colemanite. Colemanite was first found in Death Valley, Inyo County, in 1882, and in the following year the deposits were discovered at Calico, about 5 miles from Daggett, in San Bernardino County, California, and later at many places in the Tertiary lake sediments of the same general region that had previously been worked for the marsh and mud borate deposits. The production of borax and boric acid is now derived wholly from these borate of lime deposits, in which colemanite furnishes practically the entire source of supply.

It is stated by some of those engaged in the borax industry that the supply of these minerals is so abundant that little inducement is held out to the prospector to search for an extension of the present known deposits, and, further, that the successful operation of those deposits now being worked depends chiefly on efficient management and on mine and refinery equipment. Thus, it is contended that colemanite is now known to exist in so many places and in such quantity with relation to the limited demand of the present market as to class this substance commercially with such commodities as rock salt and limestone. It is undoubtedly true that more or less favorable situation with reference to transportation facilities has a very considerable influence in the success of operation of any particular property.

The Lila C. mine of the Pacific Coast Borax Co. is the largest producer in this country at the present time. A description of this deposit is given in a subsequent portion of this report.

GENERAL DISTRIBUTION OF BORAX DEPOSITS IN THE UNITED STATES.

The accompanying map (Pl. IX) is based in greater part on data concerning the California localities, kindly furnished for use in this report by Prof. Gilbert E. Bailey, of the University of Southern California. The map shows the more important localities from which a production of borax has been reported, and which consist in greater part of the marsh and hot-spring deposits. Present production is limited to a few of the colemanite properties. The legend giving the names of the various deposits is also furnished in greater part by Prof. Bailey, some data concerning Oregon and Nevada localities having been added.

PRODUCTION.

The statistics of production of borate of lime, or colemanite, in California from 1895 to 1911, inclusive, are given in the following table:

Production of borate of lime, or colemanite, in California, 1895–1911.

Year.	Quantity.	Value.	Year.	Quantity.	Value.
	Short tons.			*Short tons.*	
1895	5,959	$595,900	1904	[b] 45,647	$698,810
1896	6,754	675,400	1905	[b] 46,334	1,019,154
1897	8,000	1,108,000	1906	[b] 58,173	1,182,410
1898	8,000	1,120,000	1907	[b] 52,850	1,121,520
1899	20,357	1,139,882	1908	[b] 25,000	975,000
1900	25,837	1,013,251	1909	[b] 41,434	1,534,365
1901	23,231	1,012,118	1910	[b] 42,357	1,201,842
1902	[a] 20,004	2,538,614	1911	[b] 53,330	1,569,151
1903	[b] 34,430	661,400			

[a] Refined product, including 2,000 short tons of crude, valued at $91,000.

[b] Crude product.

IMPORTS.

The following table shows the imports of borax and borates into the United States from 1902 to 1911, inclusive:

Imports for consumption of borax and borates into the United States, 1902–1911, in pounds.

Year.	Borax.		Borates, calcium and sodium (crude) and refined sodium borate.		Boric acid.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
1902	684,537	$20,795	186,807	$12,002	822,907	$30,439
1903	68,978	5,727	146,654	13,280	693,619	28,011
1904	153,952	10,569	89,447	6,630	708,815	27,658
1905	166,960	8,802	20,395	1,626	676,105	22,372
1906	791,425	27,343	57,711	2,436	986,021	33,200
1907	2,268,065	77,258	2,959	175	534,524	23,547
1908	641,632	22,058	40	4	385,064	14,702
1909	7,124	1,023	20,284	1,956	265,985	8,708
1910	6,860	1,170	563	66	336,466	11,164
1911	9,582	732	28,815	5,230	458,900	17,666

The world's production of borates, etc., 1900–1909.

[Metric tons.]

Year.	United States, calcium borate.	Bolivia, calcium borate.	Chile, calcium borate.	India, borax.	Germany, boric acid, crude.	Italy, boric acid, crude.	Peru, calcium borate.	German Empire (Prussia), boracite, pure.	Argentina, boric acid.	Turkey.
1900	26,387	....	13,177	224	232	2,491	7,080	217	....	....
1901	30,771	3,065	11,547	162	184	2,558	4,156	164	....	....
1902	49,725	593	14,327	....	196	2,763	5,055	172	....	....
1903	31,235	1,206	16,879	....	159	2,583	2,466	135	....	....
1904	41,411	1,196	1,673	212	135	2,624	2,675	115	....	....
1905	42,034	2,146	19,612	....	183	2,700	1,954	151	....	....
1906	52,774	....	28,996	....	161	2,561	2,598	124	....	....
1907	47,945	....	28,374	....	114	2,305	2,451	90	....	(a)
1908	22,680	....	35,039	....	128	2,520	2,870	105	....	(b)
1909	37,589	....	32,218	....	149	2,431	....	123	805	....

[a] From 6,000 to 8,000 tons exported from Marmara.

[b] 13,714 tons of crude ending March, 1908.

THE LILA C. BORAX MINE AT RYAN, CAL.

By Hoyt S. Gale.

LOCATION.

The Lila C. colemanite mine in Inyo County, Cal., is situated at the eastern foot of the Black Mountains of the Amargosa Range, 11 miles in a due southwest course from the California-Nevada State line and 16 miles due east of the lowest point in Death Valley. The settlement at the mine and mill is known as Ryan station, which is the terminus of a branch line, 7 miles long, joining the main line of the Tonopah & Tidewater Railroad at Death Valley Junction. Death Valley Junction is on the main line of the Tonopah & Tidewater Railroad, which runs from Ludlow, Cal., to Goldfield, Nev. Ryan is at an elevation of about 2,500 feet and lies at the extreme upper and western edge of the desert valley of Amargosa River at this place.

BRIEF HISTORY.

The Lila C. mine was developed by the Pacific Coast Borax Co. to replace the properties near Daggett which had been exhausted. The mine became a shipper in 1907, when the Tonopah & Tidewater Railroad was completed to near this point, running north from Ludlow, where that road connects with the Santa Fe Railway. The following note is quoted from the chapter on borax in Mineral Resources for the year 1906:

> The deposit at Lila C. mine is a colemanite vein known to be about 2,000 feet long and from 6 to 18 feet wide with a very steep dip. It carries a high-grade ore that is now (1907) being shipped, carrying a boric acid content of about 40 per cent. The development work accomplished during the last three years consists of about 3,000 feet of shafts, drifts, and tunnels, and has blocked out an ore supply sufficient to last for years. The company will take its entire supply of crude material from this mine, shipping it to its refinery at Bayonne, N. J., and its production, according to present demands, is expected to be at the rate of 30,000 short tons of high-grade ore annually. The company looks entirely to its Death Valley holdings for the future, and its undeveloped supply is stated to be wonderfully large.

Production has been practically continuous since that time. The Pacific Coast Borax Co. also owns a number of extensive colemanite properties, situated along the south side of Furnace Creek Wash between the Lila C. mine and the Furnace Creek ranch in Death Valley and elsewhere.

GEOLOGY IN THE VICINITY OF THE LILA C. MINE.

The borate-bearing beds in the vicinity of Death Valley are a part of a series of Tertiary lake beds which have received considerable attention in geologic literature. At the Lila C. mine these strata consist in greater part of very light-colored, in part greenish shales, weathering white and distinctly and evenly bedded. These shales include sandy layers, some of which are of lenticular or elongated concretionary form, some examples of which were especially noted in thin beds closely associated with the borate beds. The caves along the outcrop of the colemanite beds above shaft No. 3 exhibit well the overlying strata, which are in greater part evenly bedded very light-colored shales, but include sandy layers.

Underlying the body of thin-bedded light-colored shales that include the borax minerals are some large exposures of coarse friable sandstone or tuff, these exposures being conspicuous as bare bluffs at the wash just below the No. 2 shaft of the mine. The crest of the ridge above the borate-bearing beds is capped by a dark-gray vesicular lava, which may have been a surface flow laid down with the original lake beds and later tilted with them, as it lies approximately in the same attitude that the lake beds do. One can not be positive on this point, as there has been considerable deformation in this area and the structures are not all clearly understood. There is some of this basic lava which cuts the borate-bearing strata in dike form.

The strata in the vicinity of the Lila C. mine are considerably deformed, more, however, by faulting than by minor folding. The borate-bearing beds of the mine strike about N. 30° W. and dip about 45° NE. at the north end, near the mill, with gradually decreasing inclination to about 20° near the south end of the present workings. At places the dip runs as high as 70°, but it probably averages 45° in the mine. The general trend of these strata is markedly flexed south of the mine, however, the strike swinging southwest, as traced in that direction. The crest of the ridge in which these beds occur curves with the strike in the strata.

Undoubtedly there is much minor faulting in all of these beds, though this is difficult to trace from the surface of the ground or, in fact, even in the underground developments. The beds appear to be very irregular in thickness. In places these irregularities are probably due to bedding slips, which are evidenced in rolling slickensided walls in the mine, with corresponding irregularities in thickness of the vein. There are also many undoubted transverse slips, but the vein has usually been successfully picked up beyond these, showing but minor offsets.

Although the stratification of the inclosing strata has a very definite general trend, the beds are locally crumpled in considerable irregularity in detail. Some of this irregularity in the vein itself suggests the possibility of secondary deposition or recrystallization of the borate minerals. Nevertheless, the veins or borate-bearing beds appear to occupy a definite zone within the bedded strata. In at least one place a distinct cross fracture was observed to be filled with fissure-deposited crystals of colemanite.

The caves on the upper mine workings show the depth of surface mantle on these hill slopes to be, in general, 5 to 10 feet, so that few, if any, of the slip or cross faults encountered in the mine would be likely to show on the surface. The slips and exceeding irregularity of the borate-bearing beds have an important influence in interpreting the structure or gaining a real understanding of it for the practical operation of this property.

NATURE AND EXTENT OF THE ORE.

The greater part of the ore in the Lila C. mine is colemanite. It is locally described as found in three distinct beds, which are referred to as the "hanging wall, main, and footwall veins." The upper two are said to be separated by about 25 feet of strata. The principal mine workings are on the main bed. The other beds are reported as opened in some of the underground workings, but their relations are not always clear, owing to the extreme irregularity of the veins and wall rocks. That described as the "hanging wall" bed was seen to be worked somewhat in one of the outcrop pits, and the "footwall" had been opened in some large stopes along the main level in the mine.

The main colemanite bed varies much in thickness, attaining 15 feet or more in several parts of the mine. In outcrop it presents a rough crystalline appearance, in contrast with the evenly bedded shales which include it. As the outcrop is traced southward it rises in elevation toward the crest of the lava-capped ridge, the strike of the strata changing slightly. The continuation of the colemanite bed to the south, if it does extend farther than it has now been traced, is an unsolved puzzle. It may be cut off by a large mass of dike rock which apparently cuts in just about at that horizon, a little over half a mile south of the town site. The colemanite bed may pinch out or simply be offset by the transverse faults or slips. It appears from the trend of the known outcrop that its continuation would cross the crest of the ridge if extended south, but the general strike of the strata swings southwesterly with the direction of the crest, and it is assumed, without any very conclusive proof, that the vesicular lava capping this crest is interbedded with the sediments and thus marks a definite horizon above the colemanite bed, and that the ore bed might therefore be found in extension of the recognized outcrop by measuring to the appropriate interval below the lava. All of the lava rock here, however, does not belong to the interbedded flows, and this may lead to some confusion if used for tracing the ore.

All the ore beds contain clear glassy crystalline colemanite. There are occasional vugs of a chalky white mineral, reported as not breaking down with the other ore in roasting and as consequently rejected by the screening after the ore has been roasted. Furthermore, some of the ore beds contain mixture of clay fragments with the purer ore.

The colemanite occurs in massive, more or less distinctly crystalline form. The clear glassy crystals occur abundantly in the linings of the cavities common throughout the bed. These show well-formed short prismatic crystals ranging from a minute size to half an inch or more in length. These crystals are also found in radiating bunches, or show as a radiating or plumose structure in the mass of the bed. The more massive portion of the bed is in part crystalline, showing its distinct cleavage where fractured, the ore being in places more or less mingled with earthy or shaly matter. Pure colemanite theoretically contains 50.9 per cent of boron trioxide, 27.2 per cent of lime, and 21.9 per cent of water.

The best ore from the mine is hand sorted and shipped as mined, while the poorer grades are sent directly to the mill on the property, where it is roasted and separated from its waste before shipment. It is reported that the production of this mine is about 2,600 tons of the ore as shipped per month, and is continuous except for about two months in the summer, when the works have lately been shut down on account of the excessive heat in that climate.

MINING DEVELOPMENT.

The outcrop of the colemanite bed has been traced for about 2,500 feet by surface pits, and most of the mining development done consists of incline shafts run down on the ore from the outcrop, and also following the main bed as far as it could be traced in the various levels and stopes. There are several entrances to the mine, known as the "main shaft," nearest the mill, and in order south from the mill the "main level tunnel," "No. 1 shaft," "No. 2 shaft," "No. 3 shaft" (now caved), and "No. 4 shaft." All the shafts are inclines either on or near the dip of the main colemanite bed. There are several levels run out from these shafts to a depth of three or four levels, including the so-called "main-level tunnel" as the first. Barometrically, the third level is less than 100 feet below the first. The main level is said to extend about 3,500 feet underground. Most of the work in the mine is done by way of the main shaft and the main level tunnel.

The locations of the shafts and the outcrop as traced on the surface are indicated on the accompanying map of the property (fig. 8).

TREATMENT OF THE ORE.

The best ore in the larger pieces is sorted by hand and goes to the bins for shipment in bulk; the larger part of the ore, consisting of mixed and finer material, is put through the mill at the mine before shipment.

The treatment in the mill consists of crushing and passing through rolls so that the ore is reduced to 1-inch size or finer. This is then passed through rotary roasters or kilns. The fuel used is oil, but the flame does not come in direct contact with the ore, the kiln being fitted with an inner chamber which carries the ore.

With the heat, the colemanite decrepitates, falling to a fine white flour. The temperature at the hottest point is estimated as about 1,200°. The shaly particles and some portions of the ore do not break down and are separated from the powder by screening. The finer powder is sacked for shipment, the rest going out to the dump as waste. Thus, the roasted ore yields a high-grade product for shipment.

The total output of the mines is shipped direct to the refineries of the Pacific Coast Borax Co., at Bayonne, N. J., where it is manufactured into borax and boric acid.

The author is indebted to the Pacific Coast Borax Co. for free access to this mine and property, which was visited on March 12, 1912, and the foregoing account is published with its permission. He wishes also to express appreciation to Mr. F. W. Corkill, superintendent of the mill and roaster, and Mr. William Smitheram, superintendent of the mine, for their kindly interest and assistance.

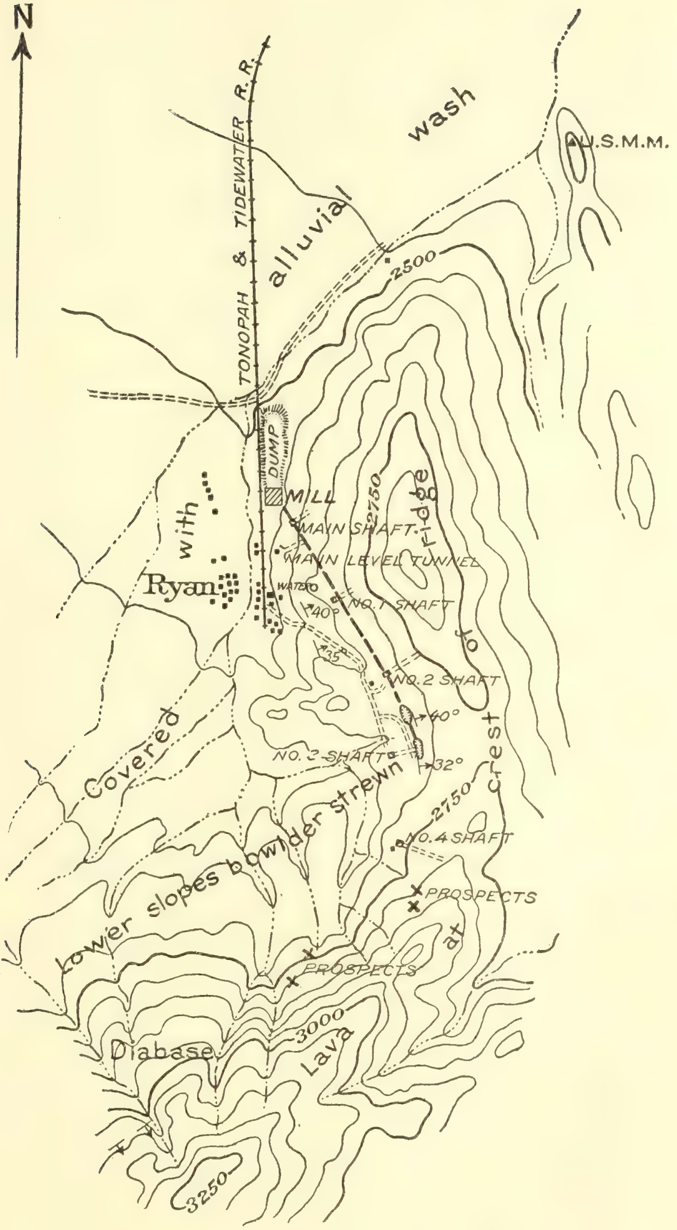
N
TONOPAH & TIDEWATER R.R.
alluvial
wash
U.S.M.M.
2500
DUMP
MILL
MAIN SHAFT.
MAIN LEVEL TUNNEL
2750
ridge
of
crest
at
with
Covered
Ryan
WATER
NO.1 SHAFT
40°
35
NO.2 SHAFT
40°
NO.3 SHAFT
32°
Lower slopes bowlder strewn
2750
NO.4 SHAFT
PROSPECTS
PROSPECTS
3000
Lava
Diabase
3250
0
1000
2000
3000 Feet

FIGURE 8.—Sketch topographic and outline geologic map of the vicinity of Lila C. borax mine at Ryan, Cal. Elevations are barometric, based on assumed elevation at Ryan.

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——— Borax and its products, tariff hearings before the Committee on Ways and Means, 51st Cong., 1st sess., Misc. Doc. No. 176, 1890, p. 361.

FLUORSPAR AND CRYOLITE.

By Ernest F. Burchard.

FLUORSPAR.

INTRODUCTION.

Among the noteworthy features of the fluorspar industry in 1911 were the large increases in the quantity of domestic spar sold and in the average price per ton and the decreases in the quantity of spar imported and in the declared value per ton of the imports. This highly satisfactory showing in the face of adverse conditions in the steel trade, on which the fluorspar market principally depends, was largely due to the ability of American producers to meet the demand more nearly than heretofore, and to produce a better and more uniform grade of gravel spar than can be obtained by importation. In the spring of 1911 a large new fluorspar mill was completed at Rosiclare, Ill., a brief description of which was given in Mineral Resources for 1910, and detailed illustrated descriptions of which were published in certain trade papers.[1]

The successful results of the first year's operations of this mill are shown in the increased production for 1911.

PRODUCTION.

The total quantity of domestic fluorspar reported to the Survey as marketed in the United States in 1911 was 87,048 short tons, valued at $611,447, compared with 69,427 short tons, valued at $430,196 in 1910, an increase in quantity of 17,621 short tons and in value of $181,251. This increase represented more than 25 per cent of the quantity and 42 per cent of the value of the production of 1910. The production in 1911 was the largest ever recorded. The total quantity of domestic gravel spar marketed in 1911 was 69,825 short tons, valued at $420,932, compared with 52,013 short tons, valued at $282,561, in 1910. The average price per ton for the whole country, considering all grades of fluorspar, was about $7.02 in 1911, compared with $6.20 in 1910. The average price of fluorspar in 1911 was, like the total quantity sold, the highest yet recorded. This value represents the selling price on board at railroad or water shipping points, and with reference to the product from Colorado, New Mexico, Kentucky, and New Hampshire, the price reported for much of the spar includes the cost of a long wagon haul—$1.50 to $3 a ton. In Illinois the principal producing mines are near river transportation, and the cost of long wagon hauls has not entered into the reported value of the fluorspar. The average price per ton of domestic gravel spar was $6.03 in 1911, as compared with $5.43 in 1910.

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[1] Burchard, E. F., Fluorspar mining at Rosiclare, Ill.: Eng. and Min. Jour., Dec. 2, 1911, pp. 1088–1090. See also Iron Trade Rev., Dec. 16, 1911, pp. 1046–1051.

Fluorspar was produced in 1911 in Illinois, Kentucky, New Mexico, New Hampshire, and Colorado in the order named, each State, except Kentucky and New Mexico, reporting an increased production. The product of Colorado, New Mexico, and New Hampshire has been classed as gravel spar, although much of the New Mexico product is equal to the grade of lump spar. Both Illinois and Kentucky produced gravel, lump, and ground spar.

The following table gives the quantity and value of the different grades of fluorspar marketed in the United States, by States, in 1910 and 1911:

Fluorspar marketed in 1910 and 1911, in short tons.

State.	Gravel.		Lump.		Ground.		Total quantity.	Total value.
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.		
1910.								
Illinois	35,477	$178,880	6,151	$38,415	5,674	$60,469	47,302	$277,764
Kentucky	11,414	75,823	2,972	20,359	2,617	28,392	17,003	124,574
Other States [1]	5,122	27,858					5,122	27,858
Total	52,013	282,561	9,123	58,774	8,291	88,861	69,427	430,196
1911.								
Illinois	55,869	337,919	3,357	24,018	9,591	119,698	68,817	481,635
Kentucky	8,128	49,775	1,045	7,813	3,230	38,986	12,403	96,574
Other States [1]	5,828	33,238					5,828	33,238
Total	69,825	420,932	4,402	31,831	12,821	158,684	87,048	611,447

[1] Includes, 1910, Colorado and New Mexico; 1911, Colorado, New Hampshire, and New Mexico.

In 1911 Illinois produced a total of 68,817 short tons of spar, valued at $481,635, or nearly $7 short ton on board cars. The gravel spar amounted to 55,869 short tons, valued at $337,919, or nearly $6.05 per ton. The scales of lump spar in Illinois were 3,357 short tons, valued at $24,018, or $7.15 per ton. The ground spar sold in this State amounted to 9,591 short tons, valued at $119,698, or $12.48 per ton. From Kentucky were reported total sales of 12,403 shor tons of spar, valued at $96,574, or an average price of $7.79 per ton distributed as follows: Gravel spar, 8,128 short tons, valued a $49,775, or $6.12 per ton; lump spar, 1,045 short tons, valued a $7,813, or $7.48 per ton; ground spar, 3,230 short tons, valued a $38,986, or $12.07 per ton. Colorado, New Mexico, and New Hampshire together produced 5,828 tons of gravel spar, valued at $33,238 or an average of $5.70 per ton. The total stocks of fluorspar reporte on hand in all the States, December 31, 1911, were 8,205 tons, mos of which was reported from Illinois and Kentucky.

The annual production of fluorspar in the United States since 188 is given in the following table:

Production of fluorspar in the United States, 1883–1911, in short tons.

Years.	Quantity.	Value.
1883	4,000	$20,000
1884	4,000	20,000
1885	5,000	22,500
1886	5,000	22,000
1887	5,000	20,000
1888	6,000	30,000
1889	9,500	45,835
1890	8,250	55,328
1891	10,044	78,330
1892	12,250	89,000
1893	12,400	84,000
1894	7,500	47,500
1895	4,000	24,000
1896	6,500	52,000
1897	5,062	37,159
1898	7,675	63,050
1899	15,900	$96,650
1900	18,450	94,500
1901	19,586	113,803
1902	48,018	271,832
1903	42,523	213,617
1904	36,452	234,755
1905	57,385	362,488
1906	40,796	244,025
1907	49,486	287,342
1908	38,785	225,998
1909	50,742	291,747
1910	69,427	430,196
1911	87,048	611,447
Total	686,779	4,187,102

TRADE CONDITIONS.

The demand for American fluorspar at Pittsburgh, Birmingham, and other steel-making centers during 1911 was apparently greater than the capacity of the mills operating in the Illinois-Kentucky district. Prices advanced considerably, partly on account of the increased cost of mining, but many of the smaller companies were idle in both States. Many steel plants purchased reserve stocks in anticipation of possible future scarcity of fluorspar. The steel plant at Pueblo, Colo., took the whole output of the Colorado and New Mexico producers in 1911, besides some spar from Illinois. As noted on another page, the imports decreased considerably, partly on account of the import duty of $3 per ton and partly through the superior quality of the domestic spar marketed.

Wholesale market quotations on fluorspar at the close of 1911 were as follows: Domestic spar, f. o. b. Pittsburgh, per ton, lump, $8 to $10; ground, $12 to $14; foreign crude, ex dock, $8.50.

The conditions in the open-hearth steel industry have a most direct bearing on the production of fluorspar, since the greater part of the gravel spar produced is used in the manufacture of basic open-hearth steel. Although the quantity of basic open-hearth steel made in 1911 decreased 606,397 long tons, or about 4 per cent, as compared with the production of 1910, the open-hearth furnaces are evidently using a steadily increasing proportion of fluorspar as a flux.

The following table[1] shows the production of open-hearth steel during the last four years:

Production of open-hearth steel in 1908–1911, in long tons.

	Basic.	Acid.	Total.
1908	7,140,425	696,304	7,836,729
1909	13,417,472	1,076,464	14,493,936
1910	15,292,329	1,212,180	16,504,509
1911	14,685,932	912,718	15,598,650

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[1] Ann. Statist. Repts. Am. Iron and Steel Association, Philadelphia, Pa.

The trade conditions in Kentucky are fully discussed by Fohs in a recent publication.[1]

Mr. Fohs attributes the decline in fluorspar production in Kentucky to several causes, among which are (1) failure to appreciate the facts that fluorspar mining is in itself highly profitable and that the lead and zinc are helpful by-products only; (2) lack of competent engineering advice; (3) lack of sufficient capital and failure to provide adequate time for proper development of the property; (4) development of the property with a view to getting immediate results; (5) lack of skilled miners and of means of stimulating their efforts; and (6) failure to realize the limited demand for fluorspar and the necessity for creating and extending the market.

Under heading 5 Fohs gives some helpful suggestions with regard to raising the standards of mining and of living through instruction, bonuses, and welfare work.

According to many Kentucky fluorspar producers, one great hindrance to development is the lack of good wagon roads from mines to railroad or river points. It would seem that many roads might be improved for long distances by the use of mill tailings.

APPARENT CONSUMPTION OF FLUORSPAR.

No accurate estimate of the annual consumption of fluorspar in the United States can be made without a knowledge of the stocks maintained by the consumers. These stocks are probably quite variable, but since the value of fluorspar as a flux in open-hearth steel making and in other metallurgical operations has become so generally appreciated, consumers are taking care to keep larger stocks in reserve. However, the sales of domestic spar plus the imports (there are no considerable exports at present) should give from year to year an index to the quantity entering into consumption and should indicate the relative increase or decrease in consumption. The net increase in apparent consumption during 1911 as compared with 1910 is 7,987 short tons, or about 7 per cent.

Apparent consumption of fluorspar, 1910 and 1911, in short tons.

	Sales of domestic spar.	Imports.	Apparent consumption.
1910	69,427	42,488	111,915
1911	87,048	32,764	119,812

IMPORTS.

Before August, 1909, fluorspar was imported into the United States duty free, and the full statistics of importation were not given before that date. Large quantities of gravel spar produced at a low cost from the tailings of lead mines and from the gob in abandoned mines in England have been shipped to this country as ballast at a very low freight rate. The material thus produced is high in silica and is almost entirely consumed by open-hearth steel makers. Before 1909 spar from England competed with American fluorspar as far west as Pittsburgh and practically fixed the market price at that point. In the Lehigh and Susquehanna Valleys of Pennsylvania and other localities near the Atlantic seaboard English fluorspar can yet be purchased advantageously under present conditions, and large quantities are consumed annually in the open-hearth steel furnaces. The imports of fluorspar entered for consumption into the United States in 1911 were 32,764 short tons, valued at $80,592, as compared with 42,488 short tons, valued at $135,152 in 1910. The value assigned to the material in 1911 was $2.46 per ton, as compared with $3.18 per ton in 1910. The imports of fluorspar in 1910 amounted to more than 81 per cent of the domestic production of gravel spar, but in 1911 they had dropped to less than 47 per cent of the domestic production. The average price, exclusive of the duty, fell from about 59 per cent in 1910 to about 41 per cent of the price of domestic gravel spar in 1911. According to the prices reported, the average cost to the consumer, including the duty of $3 per ton, but excluding freight charges, was $6.18 in 1910, as compared with $5.43 for domestic gravel spar, and in 1911 the cost of the imported material on the same basis was $5.46, as compared with $6.03 for domestic gravel spar. Notwithstanding this reversal of prices, the imports of spar decreased notably, while the production of domestic spar increased. One explanation of this singular condition probably lies in the fact that the new large mills in southern Illinois are putting on the market a higher and more uniform grade of spar than can be obtained by importation, and since fluorspar is largely sold on its percentage of purity purchasers generally prefer the best.

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[1] Fohs, F. J., The Kentucky fluorspar industry in 1910: Rept. inspector mines, Lexington, Ky., 1912, pp. 22–27.

The following table shows the imports of fluorspar into the United States since August 1, 1909:

Fluorspar imported in 1909, 1910, and 1911, short tons.

	Quantity.	Value.	Average price per ton.
1909	6,971	$26,377	$3.78
1910	42,488	135,152	3.18
1911	32,764	80,592	2.46

CHARACTER AND DISTRIBUTION OF FLUORSPAR.

Fluorspar or fluorite, chemically calcium floride (CaF_2), consists of calcium and fluorine in the proportions of 51.1 to 48.9. The mineral is crystalline, only slightly harder than calcite. It crystallizes in the isometric system and is found commonly in cubical crystals. In color the spar ranges according to purity from a clear, slightly bluish or green glasslike substance through various other brilliant colors to dark purple, although much of it is white and opaque. Fluorspar, associated with other minerals, has a broad distribution geographically and a wide range geologically. The deposits thus far exploited in the United States are, however, confined to the States of Arizona, New Mexico, Colorado, Illinois, Kentucky, Tennessee, and New Hampshire.

COMMERCIAL VALUE.

Fluorspar is a mineral of relatively low value as compared with metallic ores mined under similar conditions. Under the most favorable conditions, therefore, the margin of profit can never be expected to be large, and it requires exceptionally good management to conduct any spar mining operations profitably unless the veins are thick and of uniformly good quality. In 1911 the average value of domestic fluorspar, including gravel, lump, and ground varieties, marketed in the United States was $7.04 per short ton, and the value has ranged between $5 and $7 for the last nine years.

USES AND REQUIREMENTS.

Fluorspar is used in the manufacture of glass and of enameled and sanitary ware, in the electrolytic refining of antimony and lead, the production of aluminum, the manufacture of hydrofluoric acid, and in the iron and steel industries, in which it is used as a flux in blast furnaces and in basic open-hearth steel furnaces. It is estimated that about 80 per cent of the American fluorspar output, mainly in the form of gravel spar, is consumed in the manufacture of basic open-hearth steel. The use of fluorspar is increasing in practically all of these industries. The western market for fluorspar is more limited than that of the Central and Eastern States, but it is nevertheless increasing. Recently the iron and steel works at Irondale, Wash., and in Shasta County, Cal., have been enlarged.

Supplies of spar mined in the West have heretofore not been sufficient to supply the western market for more than a few months at a time. This has been due to several conditions, the most important of which is that most of the western spar thus far produced has not been of so high a grade as that produced in the Illinois-Kentucky district. Fluorspar for iron and steel making should carry at least 85 per cent of calcium fluoride and preferably it should be purer. For most other chemical uses it should contain from 95 to 98 per cent of calcium fluoride.

FLUORSPAR IN CANADA.

According to the preliminary mineral statistics of Canada for the year 1911 there were produced in 1911 in Canada 34 short tons of fluorspar, valued at $238, or $7 per ton, as compared with 2 tons, valued at $15, in 1910.

FLUORSPAR IN ENGLAND.

PRODUCTION.

The production of fluorspar in England has an important bearing on the industry in the United States, for practically all the competing material is imported from that country. Only since 1903 has the output of the United Kingdom exceeded 10,000 tons annually, but there has been, except in 1908, a steadily increasing annual production of spar to 1910, which is the latest year for which statistics are available. According to the official report of output of mines and quarries issued by the British home office, at London, in 1910 there were 61,621 long tons produced, valued at £20,678 ($100,629), or $1.63 per ton, as compared with 42,483 tons, valued at £16,029 ($78,005), or $1.84 per ton, produced in 1909. Of the 1910 output, 19,410 tons were produced from mines in Derbyshire, including large quantities produced from mine dumps, and 18,133 tons from quarries in the same county, and 24,078 tons were produced from mines and mine dumps in Durham. Comparing the 1910 output with the imports of fluorspar into the United States, and considering that the latter are derived almost wholly from England, it is evident that nearly 62 per cent of the British production was shipped to the United States in 1910. Minor quantities are exported to continental Europe and to Canada and from 17 to 25 per cent of the output is used at home.

SOURCE AND MINING CONDITIONS.

As is well known, a large proportion of the fluorspar produced in England is obtained by screening from waste dumps of old lead mines. Opinions differ as to the ratio between the quantities of fluorspar that are mined or quarried and those that are recovered from old workings, but it has been estimated by persons familiar with conditions in England that from 30 to 35 per cent of the ore produced is recovered from old dumps, and that the remainder is actually mined. According to another authority, more than 90 per cent of the gravel spar shipped is obtained from waste piles resulting from long-abandoned lead mines. The same authority considers that this source of supply is unlimited—that there are millions of tons of fluorspar-bearing material scattered over a large area, some of it well situated for transportation and some at too great a distance to be hauled economically by carts or motor trucks. An authority of equal standing believes that the supply at present in sight will last but a comparatively short time, but probably this estimate refers specifically to that portion of the supply which is conveniently situated for transportation and which may therefore be readily and profitably handled. This gravel spar carries 50 per cent to 80 per cent of calcium fluoride (CaF_2).

Estimates obtained from operators as to the costs of producing fluorspar in England are of interest. It is reported that spar mined by sinking shafts and driving levels costs from $3.04 a ton upward, on the ground, and the cost of haulage to the railway is from 25 cents to $1 a ton. Only the highest grade of spar, carrying 95 per cent or more of calcium fluoride, is worth mining in this manner, and only a small proportion of the output consists of spar of this grade. Spar mined from open quarries is estimated to cost about $2.43 a ton, delivered on railroad cars. Many of these quarries are adjacent to railways. The grade of spar thus obtained carries generally between 80 and 90 per cent of calcium fluoride. The spar taken from waste heaps costs at least 60 cents a ton less than spar that is mined, it is estimated, so that the cost would perhaps approximate $1.75 to $1.85 a ton loaded into railway cars. The output of one large firm is transported from mine dumps to the railway by means of steam traction trucks and by trains of tram cars drawn by traction engines.

In view of the close correspondence between the estimated cost of production of spar from mine waste and the values of the output given by the British official reports, it is evident that the greater part of the fluorspar produced at present in England is obtained from mine dumps.

CRYOLITE.

PRODUCTION.

No cryolite is produced in the United States, the entire supply used in this country being imported from Greenland.

IMPORTS AND PRICES.

The quantity of cryolite reported to have been imported for consumption into the United States in 1911 was 2 007 long tons, valued at $47,093, as compared with 36 long tons, valued at $2 343, in 1910. The average value per ton declared in 1911 was apparently $23.46, as compared with $65.08 in 1910. Cryolite is imported free of duty. Refined cryolite is relatively high priced, selling in carload lots at the close of 1911 at 5¾ cents per pound, or $128.80 per long ton.

CHARACTER.

Cryolite is a double salt of sodium fluoride and aluminum fluoride ($3NaF.AlF_3$). It crystallizes in the monoclinic system and has a hardness but little greater than that of gypsum, namely, 2.5. It is found associated with other minerals such as siderite, sphalerite, galena, chalcopyrite, and quartz. The color of cryolite is generally pure white, but in places smoke-colored pieces are found which contain well-developed crystals of red fluorspar.

SOURCE

Cryolite has been found in commercial quantities only at Ivigtut, an Eskimo hamlet on the southern coast of Greenland in latitude 61° N. Minerals containing cryolite have been found near Pikes Peak, Colo., but not in paying quantities. The cryolite deposit at Ivigtut is reported to be a solid mass having surface dimensions of about 200 feet by 600 feet, and it has been worked as an open cut to a depth of about 150 feet. The deposit widens with depth, and the depth is unknown.

USES.

Formerly cryolite was used to produce soda and alum, but other and cheaper sources of these materials have displaced cryolite from this particular field. The more important uses at present for cryolite are in the manufacture of opaque glass for the enameling of iron ware, in the metallurgy of aluminum, and as a flux in the manufacture of white Portland cement.

LITERATURE ON FLUORSPAR AND CRYOLITE.

For details as to occurrence, geologic relations, mining developments, and notes on the technology of the preparation and uses of fluorspar the reader is referred to the following papers:

Bain, H. F., The fluorspar deposits of southern Illinois: Bull. U. S. Geol. Survey No. 255, 1905.[1] 15c.

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Baldauf, —— Ueber das Kryolith Vorkommen in Grönland: Zeitschr. prakt. Geologie, December, 1910, pp. 432–436.

Betts, A. G., The manufacture of hydrofluoric acid: Mineral Industry, 1906, pp. 330–332.

Burchard, E. F., Production of fluorspar and cryolite in 1910: Mineral Resources U. S. for 1910, pt. 2, U. S. Geol. Survey, 1911, pp. 703–716.

——— Fluorspar in Colorado: Min. and Sci. Press, Aug. 21, 1909, pp. 258–260.

——— Fluorspar in New Mexico: Min. and Sci. Press, July 15, 1911, pp. 74–76.

——— Fluorspar mining at Rosiclare, Ill.: Eng. and Min. Jour., Dec. 2, 1911, pp. 1088–1090.

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Canby, H. S., The cryolite of Greenland: Nineteenth Ann. Rept. U. S. Geol. Survey, pt. 6 (continued), 1898, pp. 615–617.

Darton, N. H., and Burchard, E. F., Fluorspar near Deming, N. Mex.: Bull. U. S. Geol. Survey No. 470, 1911, pp. 533–545.

Deplace, R., Separation of ores and minerals, especially certain fluoriferous blendes from their gangue and impurities (French Pat. 420,008, Nov. 10, 1909): Jour. Soc. Chem. Ind., Mar. 31, 1911, p. 369.

Egglestone, W. M., The occurrence and commercial uses of fluorspar: Trans. Inst. Min. Eng., vol. 35, pt. 2, London, England, May, 1908, pp. 236–268.

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Halland, A. S., Cryolite and its industrial applications: Jour. Ind. and Eng. Chem., February, 1911, pp. 63–66.

Hutchison, R. S., The Rosiclare Lead & Fluorspar Mining Co.: Mine and Quarry, May, 1911, pp. 505–507.

Miller, A. M., The lead and zinc bearing rocks of central Kentucky: Bull. Kentucky Geol. Survey No. 2, 1905.

Priehäusser, M., Die Flusspatgänge der Oberpfalz: Zeitschr. prakt. Geologie, July, 1908, pp. 265–269.

Ulrich, E. O., and Smith, W. S. T., The lead, zinc, and fluorspar deposits of western Kentucky: Prof. Paper U. S. Geol. Survey No. 36, 1905.

Watson, T. L., Lead and zinc deposits of Virginia: Bull. Virginia Geol. Survey No. 1, 1905, p. 42.

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[1] Out of stock, but usually accessible in libraries of cities, technical schools, and universities, and for sale by the Superintendent of Documents, Government Printing Office, Washington, D. C.

PHOSPHATE ROCK.

By F. B. VAN HORN.

INTRODUCTION.

Since the report for 1910 was issued there have been a few developments of interest to the phosphate industry. A new territory in central Kentucky has been prospected, and it seems reasonable to predict that considerable rock will eventually be produced from that State. Phosphate rock has also been reported from Putnam and Jackson counties, Tenn., although no shipments have been made. Continuation of work by the Survey on the deposits of the Western States has largely increased previous estimates of tonnage and has also resulted in the discovery of new deposits in Montana. The latest published figures of tonnage in the Western States show that there are in these deposits probably more than 2,500,000,000 tons of minable phosphate rock carrying 70 per cent or more of tricalcium phosphate.

In order to meet the demand for information concerning all phosphate deposits of the United States, it has been thought best to republish the portion of the report for 1910 relating to the location and character of these deposits.

LOCATION.

There are at present five producing phosphate fields in the United States. In the order of quantity of production they are (1) Florida, (2) Tennessee, (3) South Carolina, (4) Arkansas, (5) Idaho, Wyoming, and Utah.

By far the largest of these fields is the one named last, where enormous deposits of high-grade phosphate rock are available for mining. The field next in available unmined rock is probably Tennessee, where large areas are underlain by deposits of high-grade rock. Florida has a large reserve tonnage, but at the present rapid rate of mining it will not be many years before the rock will be exhausted. South Carolina has been mining phosphate rock since 1868, and the production has steadily declined since 1889, with the exception of two or three years, when a slight increase in production was noted. Arkansas has never been much of a factor, and the deposits of this State are not of great extent.

FLORIDA DEPOSITS.

The Florida deposits occur in a general way along the Gulf coast. They are of three classes—hard rock, land pebble, and river pebble. Of these the land pebble is probably of most importance.

The age of these deposits has not yet been fully determined. All that can be said is that they have resulted from the alteration of phosphatic limestone of lower Oligocene age, and that probably all of the alteration has taken place during later geologic periods.

Hard rock.—The area of hard-rock phosphate at present productive lies in the western part of central peninsular Florida and extends as a narrow strip parallel with the Gulf coast in a general north and south direction from southern Suwanee and Columbia counties to Hernando County, a distance of 100 miles.

The hard rock occurs both as bedded rock and as a bowlder deposit in a soft matrix of phosphatic sands, clays, and other materials. The thickest bed known is at least 20 feet thick, and possibly much more than that.

The bowlders in the bowlder deposits vary in size from a few inches up to 8 or 10 feet, and lie embedded in all positions, surrounded by sand and clay containing more or less phosphate of lime in finer particles, resulting from a general distribution of the disintegrated portions of the bowlders during deposition. The pockets in which they occur vary in size from a few feet to several acres. The phosphate content of this class of deposits is from 10 to 30 per cent of the mass, and the rock itself runs as high as 85 per cent of tricalcium phosphate.

Land pebble.—The pebbles making up this deposit range from minute size to that of a walnut. They are originally white, but become dark when subjected to water action. They are embedded in sand and are underlain by a stratum of tough, stiff, clayey material. Above the deposit is an overburden from 1 to 25 feet thick, consisting of sand and limestone bowlders. The proportion of phosphate to other rock of this class of deposits varies from 10 to 25 per cent.

The land pebble is found resting on Pliocene marls, and is probably a residual deposit resulting from the leaching out of lime carbonate from soft limestone and marls and the breaking up of the phosphate rock into small fragments, with possibly some concretions. These fragments are mainly residual, but they have probably also been moved and concentrated in valleys by rivers and the shallow sea. The pebbles are waterworn, and shark's teeth are plentiful in the deposit.

River pebble.—The river pebble deposits have resulted from water transportation of particles of phosphate rock and deposition in favorable places, probably during Pleistocene time.

TENNESSEE DEPOSITS.

These deposits occur in the central portion of Tennessee in Hickman, Maury, Williamson, Perry, and Lewis counties. They are of three classes as described by Hayes [1]—brown residual phosphate, blue bedded phosphate, and white phosphate.

Brown phosphate.—The brown phosphate is of Ordovician age and is the result of the leaching process to which the phosphatic limestones have been subjected. Surface waters bearing carbonic and other organic acids have dissolved and carried away a large part of the calcium carbonate forming the limestone, leaving the brown calcium phosphate as a residual product. It occurs as blanket deposits and as collar deposits—the former being a deposit which caps a small hill or slope and the latter, as the name indicates, being the leached outcropping edges of the phosphatic limestone. They occur at a number of horizons in workable quantities. The principal deposits are in the vicinity of Mount Pleasant, Tenn., where they have been worked since 1893. The brown rock as mined carries as much as 80 per cent tricalcium phosphate.

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[1] Hayes, C. W., and Ulrich, E. O., Columbia folio (No. 95), Geol. Atlas U. S., U. S. Geol. Survey, 1903.

Blue phosphate.—The blue bedded phosphate is of Devonian age and shows variations from oolitic through compact and conglomeratic to shaly forms. There is also a nodular variety which occurs in a greensand formation immediately overlying a black shale. The bedded rock occurs in seams varying from 1 to 50 inches in thickness, but the high-grade rock is rarely more than 28 inches thick. The phosphatic content ranges from 30 to 85 per cent tricalcium phosphate. The nodular variety is not so high, and does not pay to work except where the bedded rock is mined by stripping off the overburden.

White phosphate.—The white phosphate is of post-Tertiary age and has been described by Hayes[1] as occurring in three different forms—stony, brecciated, and lamellar.

The stony phase is probably the result of replacement of calcium carbonate by the phosphate in places where conditions were favorable for such a transfer of material. This phase of the rock usually carries less than 50 per cent lime phosphate.

The brecciated form of the phosphate consists of masses of calcium phosphate cementing Carboniferous chert fragments.

The lamellar variety consists of plates of irregular shape and extent which were probably deposited in layers in large or small cavities.

The brecciated and lamellar forms carry as much as 85 per cent tricalcium phosphate. None of this white phosphate of Tennessee is now being mined.

SOUTH CAROLINA DEPOSITS.

The phosphates of South Carolina occur in a belt along the coast running back as far as 20 miles from the ocean, and extending from the source of Wando River, in Charleston County, to the mouth of Broad River. The rock occurs in two forms—land rock and river rock.

Land rock.—The land rock is probably of Miocene age and consists of so-called pebble rock, which is, in fact, a solid mass from which the calcium carbonate has been leached out and partially replaced by phosphate, leaving cavities which connect and penetrate through the rock, giving it the appearance of being made up of separate pebbles. The bed is from 1 to 3 feet thick and is overlain by a greensand marl.

River rock.—The river rock is so called because it is mined from river channels. It consists essentially of water-rounded fragments of the land rock.

The South Carolina rock is of comparatively low grade, running from 55 to 58 per cent tricalcium phosphate.

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[1] Hayes, C. W., Tennessee phosphates: Seventeenth Ann. Rept. U. S. Geol. Survey, pt. 2, 1896, pp. 513-550.

ARKANSAS DEPOSITS.

In Arkansas the only point at which phosphate rock is being mined is near Batesville, in Independence County. Here the bed is rather light gray, homogeneous and conglomeratic, and contains small pebbles more or less angular in form. The bed is about 4 feet in thickness, and carries about 65 per cent tricalcium phosphate.

WESTERN DEPOSITS.

The deposits occurring in the Western States are in northeastern Utah, southwestern Wyoming, and southeastern Idaho. They are of Pennsylvanian age and occur in the Park City formation. They are by far the largest deposits in the United States, if not in the world.

Gale, Richards, and Blackwelder,[1] of the United States Geological Survey, have worked in the western phosphate field for two seasons, both on reconnaissance and on detailed geology. They divide the Park City formation into three parts—an upper cherty limestone, an interval of phosphatic shales, phosphate rock, and limestone bands, and an underlying limestone, usually massive and commonly containing much chert.

Immediately overlying the phosphatic shales is a massive ledge-forming stratum of chert or cherty limestone, and this is so prominent as to serve as a horizon marker from which to trace the outcrops of the phosphate beds themselves where they are not continuously exposed. It consists of black chert and dark cherty limestones, and varies from 80 to 200 feet in thickness.

The phosphate-bearing member of the Park City formation consists of 200 feet of massive brown to gray phosphatic shales and beds of phosphate rock with some limestone, and in places cherty bands in the upper part. Rounded or oval limestone nodules ranging from a few inches to several feet in diameter are characteristic of the phosphate beds and phosphatic shales. They consist of very dense, compact, fine-grained limestone, but carry a low percentage of phosphoric acid.

The limestone underlying the phosphate-bearing strata in the Park City formation is usually massive and of sandy composition, occurring in heavy-bedded strata which weather with a light-bluish granular or sandy surface. White calcite in small irregular crystalline patches is of rather common occurrence throughout this rock.

According to Gale and Richards's description, the rock phosphate itself is chiefly characterized by an oolitic texture, by which it can usually be recognized in the field. Rounded grains, built up in roughly concentric structure, range in size from the most minute forms visible to the naked eye or by the hand lens to pebble-like bodies half an inch in diameter; rarely larger. In unaltered specimens there is commonly no visible or distinct cementing of the oolitic grains, except where they occur scattered in a groundmass of foreign material. In the weathered condition, however, as the material is commonly found near the surface, the grains have a grayish color and are more or less distinct. The rounded ovules are also characteristically distinct on weather-polished bedding planes of the more oolitic rock.

The rock phosphate varies in color from coaly black to dull gray or iron-stained. Its float is characteristically marked with a thin film of bluish-white bonelike coating, resembling chalcedony in places, with reticulated markings; this is thought to be some secondary phosphatic mineral but has not yet been studied. This coating is useful in tracing the concealed outcrop in the field by means of scattered float or fragments to be found in the overlying soil. The black color which is common in these deposits is thought to be due to bituminous matter.

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[1] Bull. U. S. Geol. Survey No. 430, 1910, pp. 457, 536.

FIELD TEST FOR PHOSPHATE ROCK.

For the benefit of those who may search for phosphate rock the following simple test is given:

Place a small crystal of ammonium molybdate on the rock to be tested, then drop a little dilute nitric acid on the crystal. If the crystal turns yellow, it indicates the presence of phosphorus. The deeper the yellow the higher the phosphate content.

METHODS OF MINING.

FLORIDA.

Pebble rock.—The land pebble phosphate of Florida is mined by hydraulicking. If the overburden is of a nature to permit, it is removed by hydraulic giants. If it consists of bowlders, however, it is usually removed by steam shovel.

In case the giant is used a stream of water is forced against the bank at a high pressure. The material is disintegrated and carried to a sump hole, from which it is taken by a centrifugal sand pump and carried to the waste bank. When it is necessary to use the steam shovel, the cost of mining usually is much greater.

After the removal of the overburden the phosphate itself is hydraulicked in the same way as the overburden. The giants wash the pebble rock into ditches which lead to the sump hole. From here one sand pump takes it up to the washer, where a second one discharges the material at the top of the washer. The pump and motor in the pit are on skids and protected by temporary shelter, so they can easily be moved from one part of the pit to another.

The washer generally used has been described by H. E. Memminger, from whose paper the following extracts are quoted:[1]

> The general design of washers throughout the district is similar, but in details of construction they vary widely. They all maintain the general scheme of pumping the rock-bearing matrix into a separator where the pebble is separated from the clay balls, large sand rocks, and other large débris, passing the rocks through log agitators, and finally passing it over or through rinsing screens. But the variations come in the number of sets of logs, number and type of screens, and final method of disposing of the rock.
>
> One of two types has been used on all plants with which the writer has been connected, both the same as regards the washing part, but differing in that one is on a floating structure, or dredge, while the other is on land, or the land type, as it is called. * * * The matrix is pumped up into the separator by tandem 10 by 8 inches centrifugal sand pumps. * * * This separator is a cylinder 12 feet long by 48 inches in diameter, punched "hit and miss" with 1-inch round holes. It is inclined on a slope of 1 on 6 and makes about 12 revolutions per minute. As none of the pebble phosphate rock is of such a size as to be retained by a 1-inch hole, approximately all of the pebble passes through, while the larger clay balls, etc., are retained and worked down into a trough, where they are carried off by a stream of water continually supplied from pipes.

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[1] Eng. News, vol. 60, No. 16, Oct. 15, 1908.

> The pebble rock is caught on an adjustable screen * * * and washed down into the logs. This screen is 18 feet long by 6 feet wide, punched "hit and miss" with $\frac{1}{16}$-inch by $\frac{1}{2}$-inch perforations, and inclined on a slope of approximately 1 on 12. It is made with the higher end adjustable in order to accommodate the slope to the various grades of rock. Material, such as sand, dirt, etc., that passes through the screen is carried to the same trough that receives the débris from the separator.
>
> The logs in this type of washer are four in number, arranged in pairs. The pairs are identical in arrangement, so a description of one set will suffice for both. They are simply blades or flukes bolted to 8 inch by 18 feet cast-iron pipes, and caused to rotate in opposite directions by means of spur gears. * * * These gears are on a 6-inch shaft bolted with flange unions to the 8-inch pipe logs. The logs are spaced 36 inches apart, center to center, and revolve at 25 revolutions per minute. The blades are just of sufficient length to miss each other in rotating. The pair of logs are set on an upward incline of 1 on 24 and depend on the pitch of the rotating blades to push the rock forward and into the chutes. The inclosing wooden box is kept full of running water with a discharge opening in the rear. The logs agitate the material, mixing and washing it thoroughly, with the same motion that forces it forward. The débris-laden water, as already stated, escapes through an opening in the rear of the logs, and is carried away in troughs.
>
> From the first pair of logs the rock, now partially cleaned, passes into a revolving rinsing screen where it receives a thorough rinsing. This screen is a double cylinder 12 feet long. The outer shell is 48 inches in diameter and the inner 36 inches, and both are perforated the same as the flat screen already described—that is, $\frac{1}{16}$ inch by $\frac{1}{2}$ inch. They are inclined downward on a slope of 1 on 12 and rotate at 12 revolutions per minute. Water pipes, perforated in rows so as to distribute the water along the whole length of the screens are run both inside and out. The débris passing through these screens is caught in a wooden trough and carried away. It has been found that to facilitate the passage of the rock through the screen it is necessary to introduce flights to assist gravity down the slope.
>
> From the screens the rock falls into another set of logs, the same in every detail as the first; passes from them into another rinsing screen the same as the last, and thence into the receiving hopper.
>
> From the receiving hopper the now thoroughly cleaned rock has two routes which it may follow. When cars are available they are run under the hopper and the rock is discharged directly into them through a gate in the bottom. In case, however, there is delay in getting the cars spotted an elevator, driven by a friction clutch from the main driving shaft, delivers the rock into a bin joining the washer. Cars may then be run under this bin and loaded through bottom gates.

The washed rock is usually run up on an elevated track and dumped into a hopper from which it is taken up into the wet bins by an elevator. From these bins it is drawn by chutes leading to another elevator which takes it up to another hopper which feeds it directly into the driers.

Mr. Memminger describes the driers as follows:

> The driers are of the revolving cylinder type with diaphragms, flights, and showering shelves similar to, though smaller than, the ones used in cement manufacturing * * * They are 30 feet long by 52 inches inside diameter and make 10 revolution per minute. They are fed from the cold or smoke-box end, and discharge the rock from a flare end just outside the furnace. This type of drier has a capacity of abou 150 tons per 12 hours. * * *
>
> The dry rock is carried from the mill elevators to the dry bin by a pan conveyor This conveyor discharges into a sheet-iron hopper holding about 3 tons. Tracks run along both sides of the bin converging at the center, and immediately beneath th hopper, on a scale platform, 1-ton side-dump cars are run on the platform, the hoppe gate opened, and the rock allowed to run in until the automatic buzzer announce that a ton has run in.

This car is then pushed to the proper place and dumped. The rock is then ready for shipment.

Hard rock.—The hard rock is mined both by pick and shovel and by dredging. As a rule the overburden is removed by hydraulic giant and the phosphate rock is picked out, loaded into cars, and hauled to the top of the washer. The washer is of the same general type a that used in the pebble districts.

The Holder mine, near Inverness, affords a good example of mining by dredge. Here the overburden is first removed by hydraulicking, and the dredge is put to work on the rock. The deposit at this mine is a bowlder deposit, and many of the bowlders are so large that they must be broken before washing. This is accomplished by blasting the rock on the dipper. It is then dumped on small cars which run up an incline to the washer. At the top of the washer is a set of "grizzly" bars through which the rock passes to the washer. The washer is of the usual type, but after being washed the rock is run on a revolving picking table where any clay or limestone which may remain are removed by hand picking. The phosphate rock is then conveyed to a burning shed where it is kiln dried. A layer of rock about 6 or 8 inches deep is placed over the floor of this shed; on the top of this is placed a layer of wood about 2 feet thick, and the kiln is filled to the top with the wet rock. The wood is then fired, and in about 30 days the rock is thoroughly dried and ready for shipment.

River pebble.—This class of phosphate rock has not been mined in Florida during the last two years.

SOUTH CAROLINA.

Land rock.—The land phosphate rock of South Carolina is mined in two ways, according to the thickness of overburden, which varies from 3 to 18 feet. Where the overburden is heavy it is removed by steam shovel, which runs on its own track. As a space is cleaned in front, the track is removed from behind and placed forward. Following the steam shovel, but placed upon the bank, is a steam hoist with a clamshell dipper. The dipper is let down on the phosphate rock, grabs a mouthful, and swings it over and dumps it on flat cars, which carry it to the washer.

After the phosphate rock has been mined out for a sufficient distance across a field, the steam shovel is turned around and started back, opening up another portion of the rock for mining. The overburden from this rock is dumped into the ditch left from the previous operation, and so the process is repeated until all the rock is mined out.

When the overburden is thin it is removed by steam shovel, but the rock itself is mined by hand and loaded into buckets, which are hoisted and dumped on flat cars which carry it to the washer.

The washer and kiln used in South Carolina are very similar in character to those used in the hard-rock mining in Florida.

River rock.—The South Carolina river rock is mined by a dredge which dumps the rock into the washer. The washer is on a float and consists usually of only one screen and a picking table. The washed rock is dumped on barges and hauled to the market.

TENNESSEE.

Brown rock.—This rock is mined by stripping the overburden with a steam shovel and getting the rock out by pick and shovel. It is loaded into carts, dumped into cars, and carried up an incline to the washer, from which it goes to a rotary drier. Some of this rock is burned in kilns instead of rotary driers.

Blue rock.—This rock is mined by underground methods where the rock above is suitable for a roof. The blue rock is blasted and loaded on cars, which are hauled by mule power to an incline at the top of which the rock is dumped on a Bell crusher. From here it is run through rotary driers and dumped into elevator buckets, which carry it up to a second rotary crusher, which reduces it to a size as small as one-fourth inch. It is then carried by conveyor to a rotary screen, which separates it into what is termed sand, pebble, and rock. Connected with this screen is a dust collector, which carries the dust into a dust chamber. The dust thus saved is a very high grade phosphate rock.

ARKANSAS.

The Arkansas rock is mined at only one place near Batesville. Underground mining is necessary and the rock is blasted and loaded on mine cars and carried to the dump. The bed at this place is about 4 feet thick.

WESTERN DEPOSITS.

The western phosphate rock has been mined only to a moderate extent. Near Montpelier, Idaho, it occurs dipping at an angle corresponding with the slope of a hill. The rock is blasted first and simply rolls down the incline to a storage house, where it is loaded into wagons and hauled to the cars. This rock is bedded rock in place and needs no washing. It is shipped to the Pacific coast and manufactured into fertilizer.

This simple method of mining, however, applies only at this particular place. When the field is developed most of the mining will be carried on underground.

PRODUCTION.

There was a considerable increase in production of phosphate rock in 1911 over that in 1910. In 1911 the total marketed production was 3,053,279 long tons, valued at $11,900,693, as compared with 2,654,988 long tons, valued at $10,917,000, in 1910, an increase in quantity of 398,291 tons, or 15 per cent, and in value of $983,693, or 9 per cent. This increase was almost entirely in Florida land pebble, though Tennessee also showed a good gain. The average price of all rock showed a falling off, being $3.90 in 1911, as compared with $4.11 in 1910, a decrease of about 5 per cent.

The total production of phosphate rock in the United States from the beginning of the industry in 1867 to 1911 is shown in the following table:

Marketed production of phosphate rock in the United States, 1867–1911, in long tons.

Year.	Quantity.	Value.	Year.	Quantity.	Value.
1867–1887	4,442,945	$23,697,019	1901	1,483,723	$5,316,403
1888	448,567	2,018,552	1902	1,490,314	4,693,444
1889	550,245	2,937,776	1903	1,581,576	5,319,294
1890	510,499	3,213,795	1904	1,874,428	6,580,875
1891	587,988	3,651,150	1905	1,947,190	6,763,403
1892	681,571	3,296,227	1906	2,080,957	8,579,437
1893	941,368	4,136,070	1907	2,265,343	10,653,558
1894	996,949	3,479,547	1908	2,386,138	11,399,124
1895	1,038,551	3,606,094	1909	2,338,264	10,796,456
1896	930,779	2,803,372	1910	2,654,988	10,917,000
1897	1,039,345	2,673,202	1911	3,053,279	11,900,693
1898	1,308,885	3,453,460			
1899	1,515,702	5,084,076	Total	39,640,810	162,329,275
1900	1,491,216	5,359,248			

The production of the various kinds of rock, by States, in 1910 and 1911 was as follows:

Production of phosphate rock in the United States, 1910–11, based on the quantity marketed, in long tons.

State.	1910			1911		
	Quantity.	Value.	Average price per ton.	Quantity.	Value.	Average price per ton.
Florida:						
Hard rock	438,347	$3,051,827	$6.96	443,511	$2,761,449	$6.23
Land pebble	1,629,160	5,595,947	3.43	[a] 1,992,737	6,712,189	3.37
River pebble	0	0	....	([b])	([b])	....
Total	2,067,507	8,647,774	4.18	2,436,248	9,473,638	3.89
South Carolina:						
Land rock	[c] 179,659	733,057	4.08	169,156	673,156	3.98
River rock	([d])	([d])	....	0	0	....
Total	179,659	733,057	4.08	169,156	673,156	3.98
Tennessee:						
Brown rock	329,382	1,262,279	3.83	[e] 365,068	1,450,063	3.97
Blue rock	[f] 68,806	241,071	3.50	[f] 72,302	263,954	3.65
White rock	0	0	....	0	0	....
Total	398,188	1,503,350	3.78	437,370	1,714,017	3.92
Western States	[g] 9,634	32,819	3.41	[g] 10,505	39,882	3.80
Grand total	2,654,988	10,917,000	4.11	3,053,279	11,900,693	3.90

[a] Includes small quantity of river pebble.
[b] Included in land pebble.
[c] Includes small quantity of river rock.
[d] Included in land rock.
[e] Includes small quantity from Kentucky.
[f] Includes small quantity from Arkansas.
[g] Includes Idaho, Utah, and Wyoming.

The figures of the table are based on the marketed product. The actual tonnage mined in Florida in 1911 was 2,464,854 long tons; in South Carolina, 182,289 long tons; in Tennessee, Arkansas, and Kentucky, 444,767 long tons; and in Idaho, Utah, and Wyoming, 10,505 long tons—a total of 3,102,415 long tons mined in 1911, as against 2,626,794 long tons mined in 1910.

PRODUCTION BY STATES.

FLORIDA.

The production from Florida in 1911 was the largest in the history of the industry; it was 2,436,248 long tons, valued at $9,473,638. This represents an increase in production of 368,741 tons, or nearly 18 per cent, over 1910, when the production was 2,067,507 tons, valued at $8,647,774. The increase was mainly in land pebble, the production of which was 363,577 tons more in 1911 than in 1910. The increase in hard rock was 5,164 tons. There was a small amount of river pebble mined in 1911. The increase in total value of product was $825,864. The price of hard rock was $6.23 in 1911, against $6.96 in 1910, and that of land pebble was $3.37, against $3.43. The average price of Florida phosphate for 1911 was $3.89, compared with $4.18 in 1910—a decrease of nearly 7 per cent. In 1911 Florida furnished 79.8 per cent of the phosphate rock mined in the United States.

The following table shows the quantity and value, based on marketed product, of each variety of phosphate rock produced in Florida from 1907 to 1911, inclusive:

Phosphate rock marketed in Florida, 1907–1911, classified by grades, in long tons.

Year.	Hard rock.		Land pebble.		River pebble.		Total.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
1907	646,156	$4,065,375	675,024	$2,376,261	36,185	$136,121	1,357,365	$6,577,757
1908	595,743	4,566,018	1,085,199	3,885,041	11,160	33,480	1,692,102	8,484,539
1909	513,585	4,026,333	1,266,117	4,514,968	....	....	1,779,702	8,541,301
1910	438,347	3,051,827	1,629,160	5,595,947	....	....	2,067,507	8,647,774
1911	443,511	2,761,449	[a]1,992,737	6,712,189	([b])	([b])	2,436,248	9,473,638

[a] Includes a small quantity of river pebble.

[b] Included in land pebble.

SOUTH CAROLINA.

The production of phosphate from South Carolina dropped from 179,659 long tons, valued at $733,057, in 1910 to 169,156 tons, valued at $673,156, in 1911, a decrease of 10,503 tons, or 5.8 per cent. No river rock was mined in 1911. The average price per ton of the rock mined was $3.98, compared with $4.08 in 1910. South Carolina furnished 5.5 per cent of the phosphate rock produced in the United States in 1911.

The following table shows the quantity and value of phosphate rock marketed in South Carolina from 1907 to 1911, inclusive:

Phosphate rock marketed in South Carolina, 1907–1911, classified by grades, in long tons.

Year.	Land rock.		River rock.		Total.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
1907	228,354	$883,965	28,867	$96,902	257,221	$980,867
1908	192,263	854,837	33,232	135,044	225,495	989,881
1909	201,254	888,611	6,700	21,975	207,954	910,586
1910	[a] 179,659	733,057	([b])	([b])	179,659	733,057
1911	169,156	673,156	....	....	169,156	673,156

[a] Includes a small quantity of river rock.

[b] Included in land rock.

TENNESSEE.

There was an increase in production of phosphate rock in Tennessee in 1911. The total production for the year was 437,370 long tons,[1] valued at $1,714,017, compared with 398,188 tons, valued at $1,503,350, in 1910—an increase of 39,182 tons, or 9.8 per cent.

The price per ton of brown rock increased from $3.83 in 1910 to $3.97 in 1911, and that of blue rock increased from $3.50 in 1910 to $3.65 in 1911. The average price of all rock was $3.92 per ton in 1911, compared with $3.78 in 1910. Tennessee furnished 14.3 per cent of the entire production of the United States in 1911.

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[1] This quantity includes small productions from Kentucky and Arkansas.

The following table shows the tonnage and value of each grade of Tennessee phosphate marketed from 1907 to 1911, inclusive:

Phosphate rock marketed in Tennessee, 1907–1911, classified by grades, in long tons.

Year.	Brown rock.		Blue rock.		White rock.		Total.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
1907	594,594	$2,880,904	38,993	$142,382	5,025	$24,550	638,612	$3,047,836
1908	374,114	1,572,525	79,717	299,941	1,600	4,755	455,431	1,877,221
1909	274,410	1,035,364	66,705	275,165			341,115	1,310,529
1910	329,382	1,262,279	[a] 68,806	241,071			398,188	1,503,350
1911	[b] 365,068	1,450,063	[a] 72,302	263,954			437,370	1,714,017

[a] Includes a small quantity from Arkansas. [b] Includes a small quantity from Kentucky.

WESTERN STATES.

The total production of phosphate rock in Idaho, Wyoming, and Utah in 1911 was 10,505 long tons, valued at $39,882. This was about one-third of 1 per cent of the total production in the United States for the year.

IMPORTS.

The following table shows the imports of fertilizer into the United States for the years 1907 to 1911, inclusive:

Fertilizers imported and entered for consumption in the United States, 1907–1911, in long tons.[a]

Year.	Guano.		Kieserite and kainite.		Apatite, bone dust, crude phosphates, and other substances used only for manure.		Total value.
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	
1907	30,287	$400,054	346,266	$2,526,584	194,121	$2,579,843	$5,506,481
1908	5,728	92,659	129,063	730,934	96,091	1,153,002	1,976,595
1909	44,197	772,674	166,692	861,894	281,345	4,336,225	5,970,793
1910	33,565	667,870	585,827	2,803,933	413,918	5,782,804	9,254,607
1911	36,896	774,315	567,227	2,754,046	394,462	6,701,833	10,230,194

[a] "Fertilizers" as here used includes the articles given in the table which are grouped by the Bureau of Statistics as free of duty under the tariff law; it does not include the potassium and sodium compounds imported as fertilizers, nor "slag" and "cyanamid."

EXPORTS.

During 1911 there were exported 1,246,577 long tons of phosphate rock, valued at $9,235,388—an increase in both quantity and value over 1910, when 1,083,037 long tons, valued at $8,234,276, were exported.

PRODUCTION IN PRINCIPAL COUNTRIES.

The production of phosphate in the principal producing countries for the years 1908 to 1910, inclusive, was as follows:

Production of phosphate rock in principal producing countries, 1908–1910, in metric tons.

Country.	1908		1909		1910	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Algeria	452,060	$2,639,940	345,385	$1,999,779	(a)	(a)
Aruba (Dutch West Indies)	[b] 29,061	(c)	[b] 16,284	(c)	(a)	(a)
Belgium	198,030	355,897	205,260	460,349	202,880	$366,015
Canada	1,448	14,794	905	8,054	1,341	12,578
Christmas Island (Straits Settlements)	[b] 110,849	(c)	[b] 107,169	(c)	(a)	(a)
France	485,607	1,880,435	397,908	1,493,099	(a)	(a)
Spain	(a)	(a)				
Tunis	1,300,543	5,531,624	1,299,985	5,529,254	(a)	(a)
United Kingdom	9	68	4	29	0	0
United States	2,424,453	11,399,124	2,375,676	10,796,456	2,697,468	10,917,000

[a] Statistics not yet available.

[b] Exports.

[c] Value not reported.

POTASH SALTS: SUMMARY FOR 1911.

By W. C. Phalen.

SOURCES OF POTASH SALTS.

The possible sources of potash salts in the United States were summarized in this chapter in 1910. They are as follows: (1) Saline residues; (2) natural and artificial bitterns; (3) alunite and similar minerals; (4) the igneous rocks containing as a lower safe limit at least 6 per cent of potash (K_2O); (5) the greensand marls of Kentucky, New Jersey, Tennessee, and probably other States; (6) organic sources, including wood ashes, beet-sugar molasses and residues, wool scourings, and seaweed.

PROGRESS OF INVESTIGATION DURING 1911.

INVESTIGATIONS BY THE UNITED STATES GEOLOGICAL SURVEY.

During 1911 the search by the United States Geological Survey for potash salts covered several fields, as follows: (1) Deep drilling for saline residues; (2) the collection and examination of natural and artificial brines and bitterns; (3) the examinations of deposits of alunite and other minerals containing potassium; (4) the examination of certain occurrences of igneous rocks known to contain large quantities of potash.

INVESTIGATIONS BY THE BUREAU OF SOILS.

Besides the work of the Survey, the Bureau of Soils of the Department of Agriculture has taken up the systematic study of the seaweeds or kelps of the Pacific coast. The recent report[1] issued by the Bureau of Soils on the fertilizer resources of the United States covers the entire field, but the portion relating to the extraction of potash salts from kelp is of particular interest in this connection and will be summarized further on. The Bureau of Soils is also cooperating in the study of the bitterns referred to under (2) above. It has also undertaken a field survey of the desert basins of the arid States of the West in search of fertilizer materials, and laboratory investigations are now under way (1) to ascertain the effect of water and other reagents on the potash feldspars and other silicates, and (2) in the study of aqueous (water) solutions of mixtures of potassium and sodium salts.

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[1] A preliminary report on the fertilizer resources of the United States: S. Doc. 190, 62d Cong., 2d sess.

INVESTIGATIONS BY PRIVATE PERSONS.

Private persons are also interested in all these fields of search, and numerous investigations are known to be in progress which have for their object the discovery of a cheap and ample supply of potash salts.

The different phases of the work that has been in progress during 1911 and to date in 1912 are described in detail below.

DEEP-DRILLING EXPLORATIONS.[1]

Examples of the occurrence of potash salts on a large scale are comparatively rare. Besides the German deposits, the only known noteworthy occurrence in the world is that at Kalusez, Galicia. The great classic example is that occurring on the inner side of the Magdeburg-Halberstadt Permian basin in central Germany. At the southeastern end of this basin potash salts were discovered by drilling about the middle of the last century and were first mined at Stassfurt and Egeln. The deposits are usually referred to as the Stassfurt deposits.

It is possible that salts of the Stassfurt type found in Germany may also be found in the United States. The only method of finding these salts is by deep drilling. As a guide to this deep drilling the systematic examination of the brines and bitterns of the United States will prove helpful, for it will indicate possibly where deep drilling may be undertaken with the best chances for success. Both these phases of work were taken up at the very outset of the potash-salts investigation by the United States Geological Survey.

Deep-drilling explorations by the Survey were begun near Fallon, Nev., October 6, 1911, under the direction of H. S. Gale. The reasons for choosing this place as the site of first drilling operations have been amplified in a former publication of the Survey[2] and will only very briefly be given here.

Fallon, Nev., is located in the Great Basin region of the western United States. The region has at present no outward drainage, nor has it had for long periods of time. Its system of ancient lakes is included chiefly within Utah, Nevada, and California, but portions are also included in Oregon, Idaho, and Wyoming. Its history has been worked out by Russell[3] and Gilbert.[4] In his geologic history of Lake Lahontan, one of the Quaternary lakes of the Great Basin, Russell presents evidence favoring the possible existence of saline deposits in this region.

Lake Lahontan flooded the valleys of northwestern Nevada in very recent times, geologically speaking, but it has now disappeared. It covered an area of 8,422 square miles and was 886 feet in depth in the deepest part. It is not known to have ever overflowed. It had two high-water stages separated by a period of drying or desiccation. The first great rise was also preceded by a period of desiccation. During the second period of flooding the lake rose higher than during the first. It then evaporated completely to dryness. The present lakes of the basin are of comparatively recent date and their water is fresh, for the reason that the salts deposited when the Quaternary lake evaporated were buried or absorbed by the clays and marls that occupied the bottom of the basin.

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[1] Gale, H. S., The search for potash in the United States: Bull. U. S. Geol. Survey No. 530-A, 1911, 29 pp.
[2] Bull. 530-A.
[3] Russell, I. C., Geological history of Lake Lahontan, a Quaternary lake of northwestern Nevada: Mon. U. S. Geol. Survey, vol. 11, 1885.
[4] Gilbert, G. K., Lake Bonneville: Mon. U. S. Geol. Survey, vol. 1, 1890.

It is a rule that all lakes which have no outlet become finally charged with mineral salts. Examples of saline deposition resulting from the evaporation of inclosed lakes are common in the Great Basin. In the Lahontan basin deposits of this character resulting directly from the evaporation of a former lake are nowhere to be found. Wherever the lake sediments have been examined, however, they have been found to be charged with salts of presumably the same character as those that were most common in the waters of the former ake. It is beneath the level floors of the valleys and lake basins that the most soluble salts formerly dissolved in the waters of Lake Lahontan are buried. As between Lake Bonneville, another ancient lake of the Great Basin, and Lake Lahontan, the latter was chosen as the site of drilling operations for the reason that it never overflowed its banks and because its waters drained an area where volcanic rocks predominated. It is in such rocks, as contrasted with sedimentary rocks, that appreciable quantities of potash and soda are contained. The headwaters of Lake Bonneville, on the other hand, were located n the Wasatch Mountains, where limestones occur and where potash and soda compounds therefore are present in comparatively small quantity.

A consideration of the low points in the Lahontan basin narrowed the selection of a drill site to a few localities, and the one chosen finally s in sec. 30, T. 21 N., R. 30 E., at the north end of Timber Lake. The well is known as the Timber Lake well. In the publication by Gale cited above a summary of progress is given in considerable detail and shows the character of the rocks passed through. The well at the time the report was closed (Dec. 1, 1911) had reached a depth of 360 feet, but saline material had not been encountered in any appreciable quantity. It is expected that drilling will be continued until a depth of at least 1,000 feet is reached.

SALINES IN THE OTERO BASIN, N. MEX.[1]

The work of E. E. Free, of the Bureau of Soils, Department of Agriculture, in the Otero Basin, N. Mex., has led to the conclusion that potash salts do not occur in anything approaching commercial quantity as surface deposits in that region. The mountains bordering the basin are made up of rocks almost entirely of sedimentary origin and hence can not be expected to carry or to yield any significant quantity of potash salts. It is estimated that probably less than 5 per cent of the exposed rocks in the drainage area are potash bearing. For this reason potash salts are not entering the present drainage basin, and there is no reason to believe that the supply in the past was any greater than it is at the present. It is quite probable that saline beds underlie the present surface of the basin, but the chance that potash salts may be found associated with them is considered negligible. The conclusion is reached that the chances for finding buried beds of potash salts in this basin are less than in many other of the undrained basins of the region.

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[1] Free, E. E., Circ. Bur. Soils No. 61, Feb. 12, 1912.

POTASH SALTS IN BRINES AND BITTERNS.

OBSERVATION OF ROCK-SALT DEPOSITS.

In a previous publication of the United States Geological Survey[1] it was stated in general, with reference to the possible occurrence of potash salts in the United States, that to make a thorough and complete investigation of their occurrence, every known rock-salt deposit should be closely watched, studied, and tested from time to time. The reason for this statement lies in the fact that ordinary rock salt may both overlie and underlie deposits of potash salts. Both these conditions exist in the Stassfurt-Egeln district of Germany. The normal occurrence of rock salt is, however, at or toward the base of a series of soluble salines deposited from the evaporation of sea water and hence below the potash salts. Too great emphasis can not be laid on the investigation of rock-salt deposits for potash salts.

EXAMINATION OF SPECIMENS.

Private enterprise can and probably will go far in carrying on the investigation of the problem of a cheap and easily available supply of potash salts within the territory of the United States. The United States Geological Survey is ready and willing, so far as its limited means and equipment allow, to aid in this work, and already hundreds of inquiries have been answered and specimens examined in its offices and laboratories in Washington. All that can be done with most of the material received is to subject it to qualitative tests to determine the presence of soluble saline material. Such simple tests are, however, all that is necessary to determine the presence of soluble potash salts.

Cooperative laboratory for testing potash salts.

By a recent arrangement a cooperative laboratory has been established at the Mackay School of Mines, University of Nevada, at Reno, in which the University of Nevada, the Bureau of Soils of the United States Department of Agriculture, and the United States Geological Survey have combined in the interest of the potash investigations. This laboratory is under the administrative charge of Prof. George J. Young, at the Mackay School of Mines. Hereafter communications relating to such potash tests and samples for analysis may be directed to Prof. Young. Such tests as are deemed warranted will be made on the samples, subject to the limitations of equipment and capacity of the laboratory. A few requests have been received for the determination of supposed nitrate and phosphate samples. There is no provision in the equipment of the laboratory at Fallon for these tests, but it is expected that the Reno laboratory will be able to handle a reasonable amount of that work also.[2]

FIELD WORK.

As a part of the potash investigation carried on by the Survey in the summer of 1911, a systematic and fairly complete study of the brines, bitterns, and rock-salt deposits of the States east of the Rocky Mountains was attempted. The study was confined to the localities that were considered the most promising for the occurrence of potash salts. During the work 175 samples of brines, bitterns, and calcium chloride were collected. This does not include the large number of brine samples procured through correspondence, chiefly from oil drillers throughout the country, earlier in the year. The geology of the occurrences of the brine and the salt was investigated and many records of deep wells were obtained. Where possible, actual samples of the rocks passed through in making the deep drillings were collected. Because so few of the samples (less than 25) collected or received by the Survey have been reported on, a general statement of results at this time is impossible; but by reference to the analyses given below it will be seen that many bitterns supposed to be devoid of potash salts do in fact contain them in small amounts. Particular attention is called to a natural bittern from northern Ohio which is known to occur over a large area and which in its content of potash salts stands out from the rest.

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[1] Phalen, W. C., Occurrence of potash salts in the bitterns of the eastern United States: Bull. U. S. Geol. Survey No. 530-B, 1911, 19 pp.

[2] Bull. U. S. Geol. Survey 530-A, 1911, p. 21. See also press notice dated Feb. 17, 1912, U. S. Dept. Agr.

ANALYSES OF THE BRINE.

The samples whose analyses are given below represent only a very small part of those submitted for examination. The care with which the work is being done requires a great deal of time, consequently the work has to proceed slowly. The chemical work thus far has been done by R. F. Gardner and A. R. Merz, of the Bureau of Soils, Department of Agriculture.

Composition of certain New York bitterns.

Sample No.	Source.	Description of sample.	Constituents, in grams per liter.								Percentage of KCl in total solids.
			K.	Na.	Ca.	Mg.	Cl.	SO_4.	Total.	Content of KCl.	
2	Worcester Salt Co., Silver Springs.	Bittern from grainer	2.8	100.3	19.9	1.8	197.2	0.5	322.5	5.34	1.7
[a] 4	Remington Salt Co., Ithaca.	Bittern from vacuum pan.	1.0	109.1	10.3	1.6	191.1	.6	313.7	1.91	.6
5	Rock Glen Salt Co., Rock Glen.	Bittern 10 days old.	1.9	106.7	13.5	1.5	193.5	.8	317.9	3.62	1.1
7	Star & Crescent Salt Co., Salt Vale.	Bittern from grainer	1.8	93.7	25.2	2.6	197.5	.4	321.2	3.43	1.06
11	Genesee Salt Co., Pifford.	Bittern, 36 hours old, from grainer.	1.3	114.2	6.4	1.9	192.8	1.2	317.8	2.48	.8
[b] 18	Le Roy Salt Co., Le Roy.	Bittern going to waste outside plant.	.2	72.7	5.3	.7	122.8	1.1	202.8	.38	.2

[a] Collected by J. W. Turrentine.

[b] Diluted with water.

Composition of certain Michigan bitterns.

Sample No.	Source.	Description of sample.	Constituents, in grams per liter.								Percentag of KCl in tota solids.
			K.	Na.	Ca.	Mg.	Cl.	SO_4.	Total.	Content of KCl.	
23	Delray Salt Co., Delray (Detroit).	Bittern from grainer.	....	121.1	1.9	0.2	187.5	3.4	314.1	....	....
98	Worcester Salt Co., Ecorse (Detroit).	Bittern, 11 days old.	....	119.5	3.0	.3	189.9	.2	312.9	....	....
53	Peters Salt & Lumber Co., East Lake (Manistee).	Bittern, 19 days old, from grainer.	0.5	115.1	3.9	3.0	191.4	2.3	316.2	0.95	0.
56	Buckley & Douglas Lumber Co., Manistee.	Bittern from grainer, 4 weeks old.	.2	119.1	2.4	1.6	189.8	3.4	316.5	.38	.
59	Louis Sands Lumber Co., Manistee.	Bittern from grainer, 3 weeks old.	.7	111.1	3.5	4.6	189.8	2.3	312.0	1.33	.
61	Stearns Salt & Lumber Co., Ludington.	Bittern from grainer.	....	121.4	2.8	.3	190.4	2.4	317.3	....	....
63	Hine & Co., Bay City.	Bittern from grainer, 5 days old.	1.3	66.1	40.6	11.5	207.7	.4	327.6	2.48	.
96	Michigan Salt Works, Marine City.	Bittern, 6 weeks old, from grainer.	2.0	104.6	13.8	2.7	194.6	.6	318.3	3.81	1.

Composition of certain Ohio bitterns.

Sample No.	Source.	Description of sample.	Constituents, in grams per liter.									Percentage of KCl in total solids.
			K.	Na.	Ca.	Mg.	Cl.	SO_4.	Br.	Total.	Content of KCl.	
112	Union Salt Co., Cleveland.	Bittern from grainer 5 days old.	1.2	100.1	16.3	3.7	194.5	0.7	.....	316.5	2.29	0.
117	Ohio Salt Co., Wadsworth.	Bittern accumulating 35 days.	.7	103.7	16.5	1.3	192.3	1.1	.....	315.6	1.33	.
118	.....do.........	More concentrated bittern than No. 117; vacuum pan at boot.	1.8	97.6	12.0	2.4	187.8	1.8	.....	303.4	3.43	1.
114	Diamond Alkali Co., Fairport Harbor.	Natural bittern.	3.9	43.4	48.6	11.2	188.4	.2	.....	295.7	7.43	2.
122	Pomeroy Salt Association, Pomeroy.	Bittern before passing to bromine plant.	3.2	2.6	145.2	42.2	360.4	5.2	11.6	570.4	6.10	1.

Composition of certain West Virginia bitterns.

Sample No.	Source.	Description of sample.	Constituents, in grams per liter.									Percentage of KCl in total solids
			K.	Na.	Ca.	Mg.	Cl.	SO_4.	Br.	Total.	Content of KCl.	
120	Dixie Salt Co., Mason.	Bittern from grainer before passing to bromine plant.	....	3.3	135.8	48.4	366.2	4.8	11.0	569.5	....	....
129	Liverpool Salt & Coal Co., Hartford.	Bittern before passing to bromine plant.	....	.2	143.4	43.4	358.6	3.8	12.2	561.6	....	....

Of the analyses of bitterns given above, that of sample No. 114 from Ohio deserves more than passing notice. It was collected at the plant of the Diamond Alkali Co. at Fairport Harbor, northeast of Cleveland, on Lake Erie, from a well during the process of sinking. Samples of similar natural bitterns were procured near Akron and also at Barberton. The top of this bittern stratum varies from approximately 350 to more than 400 feet above the topmost salt bed from which artificial brines are pumped in northern Ohio. One record collected shows a difference of only 250 feet, but this seems very exceptional. It will be sufficient to state here that the bittern stratum is sharply defined and is of wide areal extent. The bittern is a bugbear to the salt industries of this part of Ohio, for if allowed to get into the brines from which salt is made it renders them bitter and as a consequence spoils the resulting salt. As a container of potash salts, this bittern may prove to be one of the richest known in the Eastern States.

On reducing the different constituents of this bittern from their ionic state to conventional combinations, the total solids would be divided as follows:

Composition of natural bittern from Fairport Harbor, Ohio.

	Grams per liter.
Potassium chloride	7.4
Sodium chloride	110.1
Calcium chloride	134.4
Magnesium chloride	43.2
Calcium sulphate	.3
Ferric chloride	.3
Total	295.7

A bittern of this composition seems to offer opportunities for research which should not be neglected.

ALUNITE AS A SOURCE OF POTASH SALTS.[1]

LOCATION OF DEPOSIT.

A deposit of alunite recently discovered near Marysvale, Piute County, Utah, is being developed and may produce potassium sulphate on a commercial scale. The deposit is located near the head of Little Cottonwood Canyon about 7 miles southwest of Marysvale, which is the present terminus of the San Pete & Sevier branch of the Denver & Rio Grande Railroad. It occurs high in the Tushar Range, at an elevation of 9,900 to 11,000 feet above sea level, or about 4,000 feet above the railroad at Marysvale station.

COMPOSITION OF MINERAL.

The mineral alunite is a hydrous sulphate of potassium and aluminum with the symbol $K_2O.3Al_2O_3.4SO_3.6H_2O$. Theoretically it contains 11.4 per cent K_2O, 37 per cent Al_2O_3, 38.6 per cent SO_3, and 13 per cent water. The composition of the Marysvale mineral, according to the analyses that follow, is very close to the composition of the pure mineral given above.

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[1] Butler, B. S., and Gale, H. S., Alunite, a newly discovered deposit near Marysvale, Utah: Bull. U. S. Geol. Survey No. 511, 1912, 64 pp.

Analyses of alunite from deposit near Marysvale, Utah.[1]

	18	19	Dana.
	Per cent.	*Per cent.*	*Per cent*
Al_2O_3	37.18	34.40	37.
Fe_2O_3	Trace.	Trace.	
SO_3	38.34	36.54	38.
P_2O_5	.58	.50	
K_2O	10.46	9.71	11.
Na_2O	.33	.56	
H_2O+	12.90	13.08	13.
H_2O-	.09	.11	
SiO_2	.22	5.28	
Total	100.10	100.18	100.

No. 18 is a selected specimen of the supposedly best material. It consists of clea pink, subtransparent, coarsely granular crystalline rock. No. 19 is a selected specime of a light pink, very finely granular rock, of almost porcelain-like conchoidal fractur and no distinct structure.

As yet the developments on the Marysvale properties have shown only what i thought to represent a single large vein of alunite.

TONNAGE.

A conservative estimate of the tonnage in this deposit may be had by assuming a average width of 10 feet in the principal vein for a total length of 3,500 feet and neglec ing the rest of the deposit as not sufficiently proved to be taken into consideration a present. This gives a surface area of substantially proved outcrop of 35,000 squar feet, or more than four-fifths of an acre. The specific gravity of the Marysvale aluni has been determined in several specimens by W. T. Schaller, with results in clos accord at about 2.82. Therefore a cubic foot of the ore may be assumed to weigh abou 175 pounds. An acre of ground underlain by this rock to a depth of only 1 foot woul contain 3,800 short tons of alunite. If the area of available alunite is only 35,000 squa feet, as stated above, there would be approximately 300,000 short tons of the rock fo each 100 feet of depth so long as the deposit maintains its surface dimensions an quality. If the recoverable potassa or potash (as K_2O) is estimated at 10 per cen of this total, such a deposit would yield 30,000 tons of potassa for each 100 feet i depth. This is approximately one-sixth to one-seventh of the total annual consum tion of potash in the United States.[2]

The Marysvale deposit, so far as known, is not of such magnitude as to afford source of all the potash salts now consumed in the United States, but it may prov to be an important factor in providing an American supply that will perhaps b especially available to local and western markets, particularly in meeting the deman for higher-grade salts. Possibly also the greatest importance of the commerci development of this deposit will be in the added stimulus it may afford to exploratio for other similar deposits of this mineral, especially in this general region, and it on the discovery of such other deposits that the provision of a home supply from th source must depend.[3]

METHOD OF RECOVERING POTASH.

Experiments by W. T. Schaller in the laboratory of the Geologic Survey have showed that on igniting the powdered alunite all th water and three-fourths of the sulphuric acid are driven off. Whe the residue is leached with water potassium sulphate dissolves an insoluble alumina is left. The average amount of potassium sulphat leached from the ignited mineral is 17.9 per cent of the origin material used. As the coarsely crystallized alunite was found t contain 19.4 per cent potassium sulphate, 92 per cent of the tot potash present was obtained by simple ignition and subseque leaching. According to the laboratory experiments 32.7 per cen of the ignited alunite consists of available potassium sulphate which may be obtained by leaching and evaporation; the remaining 67.3 per cent is nearly pure alumina.[1]

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[1] Op. cit., p. 8.

[2] Op. cit., p. 12.

[3] Op. cit., p. 6.

Several foreign deposits of alunite have been successfully worked for the manufacture of alum. The Utah mineral may be used for alum, or, as suggested by the laboratory work of W. T. Schaller, as a source of potassium sulphate and alumina.

IGNEOUS ROCKS AS A SOURCE OF POTASH.

Potash is abundant as a constituent of the rocks which form the crust of the earth. According to F. W. Clarke[2] the percentage of potash (K_2O) in the earth's crust is 2.99, this result being an average of 1,488 determinations made in the laboratories of the United States Geological Survey up to November 1, 1910. In some varieties of igneous rocks, particularly those rich in the potash feldspars, there is a large amount of potentially valuable potash. The feldspars are widely distributed minerals and comprise about 60 per cent of the igneous rocks. Among the igenous rocks containing large amounts of potash are the glasses, of which the chief are obsidian, pumice, perlite, and pitchstone. In these rocks the potash may run as high as 5 or 6 per cent. The rhyolites are also rich in potash. Examples of this rock containing more than 5 per cent of potash are common, and a certain rhyolite from Silver Cliff, Colo., has been shown to contain 8.38 per cent.[3]

The trachytes and phonolites are also rich in potash, as they consist chiefly of that variety of potash feldspar (orthoclase) known as sanidine. Some of the trachytes are known to contain nearly 8 per cent of potash. Among the granitoid rocks should be mentioned granite, monzonite, and syenite, which contain considerable amounts of the potash feldspars. The leucite rocks of the Leucite Hills, Wyoming, contain, so far as known, the largest amount of potash among the igneous rocks. In many localities there occur large dikes or deposits of more or less pure feldspar, commonly orthoclase, which run much higher in potash than the ordinary granitic rocks and may contain nearly the theoretical potash content of pure orthoclase feldspar—16.8 per cent of potash. Such deposits have been developed in the New England States, Pennsylvania, New York, and Maryland, where they have been mined extensively and the feldspar has been ground to fine powder, principally for use in pottery manufacture.

But the potash of these rocks, even when finely ground, is tightly locked up, being practically insoluble by any known cheap commercial process. Rock bearing 10, 8, or even 6 per cent of potash—and there are millions of tons of such rock well distributed over the globe—would be highly valuable as a fertilizer were there any known cheap method of making the potash available for immediate use to the growing plant.

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[1] Op. cit., p. 58.
[2] The data of geochemistry, 2d ed.: Bull. U. S. Geol. Survey No. 491, 1911, p. 27.
[3] Cross, Whitman, Proc. Colorado Sci. Soc., Dec. 5, 1887, p. 229.

PATENTS FOR EXTRACTION OF POTASH.

The problem of converting the insoluble potash in the silicat rocks into soluble form has been worked on since 1847, and at leas 30 patents bearing on it have been issued. The igneous rocks as source of soluble potash salts have been investigated recently b A. S. Cushman, Firman Thompson, and Edward Hart, a digest o whose patents is given below.

Cushman's patent No. 851922, dated April 30, 1907, is described a follows:

> Feldspathic or other potash-bearing rock is ground to fine powder, slimed with wate and placed inside of a suitable wooden container, which is then set inside of anothe larger vessel. Water is now placed in the outer vessel and electrodes inserted so tha the inner or slime chamber becomes connected with the positive pole and the oute chamber with the negative pole. A current of electricity from a dynamo is the turned on. When this is done the potash, soda, and other soluble bases are partiall set free from the combinations with alumina and silica in which they exist in th feldspathic rocks.
>
> Under the influence of electrolysis the soluble bases pass through the wooden pa tition and the water in the outer vessel becomes alkaline, owing to the accumulatio of potassium and sodium hydroxide. The electrical resistance of the cells arranged i this way is so high that only a small fraction of an ampere passes through under potential of 110 volts. After a certain percentage of the alkali has been extracted i this manner, the action slows down, and it has been found necessary to devise method to accelerate it.
>
> Dr. Cushman has discovered two methods of accelerating the decomposition of th rock slime and hastening the extraction of the potash. (*a*) By a suitable grinding c churning arrangement the slime in the inner chamber can be kept in a continu agitation, which causes the necessary reactions to go on more rapidly. (*b*) If a sma quantity of hydrofluoric acid is added to the slime a very great acceleration in the ra of decomposition and extraction is obtained, and it is possible in a reasonably sho time to make a complete extraction of all the potash contained.
>
> If instead of caustic potash it is desired to make various salts of potash such as a in ordinary use for fertilizers and other purposes—that is, nitrate, sulphate, chlorid and phosphate—the corresponding acids (nitric, sulphuric, hydrochloric, and pho phoric) are fed in a dilute form into the outer or so-called cathode chamber fast enoug to neutralize the caustic alkali as it forms. By varying the amount of acid adde the resistance of the cell can be controlled and the decomposition of the rock carrie on under the best and most economic conditions.

Dr. Cushman has recently patented another process for the extra tion of potash from rocks, in the form of a water-soluble salt or sal (patent No. 987436, dated Mar. 21, 1911). In this process th potash-bearing rock is subdivided as finely as possible, preferably s fine that it will pass through a 200-mesh screen. The powder is the mixed with a suitable amount of finely pulverized quicklime, 2 parts of lime to 100 parts of rock being a proper proportion. Th mixture is then spread on a belt or drum conveyor in a layer thre eighths to half an inch thick. A solution of calcium chloride is the applied in separate drops so that the aggregates formed shall n merge. The calcium chloride reacts with the lime, forming a oxychloride cement, and the clumps or aggregates which form on i addition harden very quickly and are separated from the rest of t mass by screening. They are then heated to a high temperature in rotary furnace or kiln, when potassium chloride is formed. T product when discharged from the furnace in the form of lumps small particles may then be ground or crushed as a fertilizer or as component of mixed fertilizers, or the potassium chloride may b extracted with water and obtained by evaporation in the form the salt.

Thompson's process is described in patent No. 995105, dated June 13, 1911. It consists of grinding feldspar rock so that it will pass through a 100-mesh sieve. The powdered rock is then mixed with an acid alkali sulphate and an alkali chloride, preferably acid sodium sulphate and sodium chloride, respectively. The proportions of the materials used are: Feldspar rock, 5 parts by weight; acid sodium sulphate, 5 parts by weight; sodium chloride, 1.8 parts by weight. This mixture is heated from one to two hours at a bright red heat and becomes thereby partly fused. The mass is then allowed to cool, is ground again, and is leached with water, which removes a mixture of sulphates of potassium and sodium. These salts are then separated by crystallization. The reactions are believed to be as follows: (*a*) The sodium acid sulphate reacts with the sodium chloride to produce hydrochloric acid gas and normal sodium sulphate. (*b*) The hydrochloric acid gas at the high temperature employed reacts on the feldspar, producing potassium chloride. (*c*) The potassium chloride is in turn acted upon by more of the acid sodium sulphate, producing hydrochloric acid gas and potassium sulphate.

The yield of potash is ordinarily from 80 to 90 per cent of the potash in the rock. For the best results the temperature must be controlled within rather narrow limits.

Hart's process is described in patent No. 997671, dated July 11, 1911. It consists in fusing orthoclase with a barium compound and carbon, usually in the form of powdered anthracite coal or other reducing agent. The addition to the insoluble silicates of basic oxides like barium monoxide (its equivalent in barium sulphate is used) or lead monoxide, followed by fusion results in a silicate readily decomposed by sulphuric, nitric, or hydrochloric acids. When such a fusion is treated with sulphuric acid, for example, there are produced potassium sulphate, barium sulphate, and aluminum sulphate. A solution of the soluble compounds in this mixture on evaporation gives crystals of potash alum. The insoluble parts consist chiefly of barium sulphate and silica. The strong point claimed for this invention is that the large amounts of residual material left after the extraction of the potash salts are of value as pigment in the manufacture of paints.

B. Herstein[1] has outlined a process for the extraction of potash salts from feldspar. It consists in heating the finely ground potash feldspar with calcium chloride, adding eventually some limestone. By the process proposed the silicate is decomposed with the formation of potassium chloride and calcium silicate or aluminate. The process differs from the well-known J. Lawrence Smith method only in the fact that the calcium chloride is used here directly, while in the other the silicate is heated with a mixture of ammonium chloride and calcium carbonate. It has been experimentally shown that the reaction can be carried out and the feldspar decomposed by the use of very little more than the theoretical amount of calcium chloride, provided the materials are intimately mixed and the temperature well regulated and maintained a sufficient length of time. The points in the process which make it attractive, according to Herstein, are as follows: (1) Calcium chloride is a waste product or at most has but a nominal value; (2) the residue left after the potash salts have been removed contains all the essential elements of a cement, int which it could be transformed by ignition with the addition of limestone, if necessary. This residue does not require grinding, for i the temperature is kept reasonably low the mass does not clinke and disintegrates easily in water.

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[1] Jour. Ind. and Eng. Chemistry, vol. 3, No. 6, June, 1911.

A second method of procedure is suggested in which the tw stages of the process outlined may be combined into one.

POTASH-BEARING ROCKS OF THE LEUCITE HILLS, WYOMING.[1]

LOCATION.

In connection with the problem of the extraction of potash salt in soluble form from the igneous rocks a source of supply of th latter, rich in potash salts, becomes a matter of interest. Th igneous rocks, as stated above, are very widespread. They are, however, made up largely of quartz and other nonpotash-bearin minerals. Their potash content varies considerably but is alway low. One of the richest potash-bearing rocks known in the Unite States is found in the Leucite Hills, Wyoming. Objection has bee raised to this rock as a source of potash, owing to its remote locatio from the chief centers of consumption. It is true that the Leucit Hills are located remotely from the southern Atlantic States, whic are at the present time the great consumers of artificial fertilizer It will be, however, only a short time before certain of the Middle an Western States must use artificial fertilizers, and in some of ther such use has already begun. This objection, therefore, to the Wyoming material can not be regarded as wholly valid.

The Leucite Hills are located in the north half of the Rock Spring dome, Sweetwater County, Wyo. The Union Pacific Railroad is th only line crossing this area, and spur tracks would have to be constructed from its main line along the larger valleys or main stream to tap the leucite-bearing area.

SUMMARY OF AVAILABLE LEUCITE-BEARING ROCK.[2]

The potash contained in the leucite-bearing rocks occurs in th minerals leucite, phlogopite, one of the micas, sanidine, the glass variety of orthoclase, glass, and to a small degree in diopside. Th greater part of the potash occurs in the first two minerals named. Th chemical analyses of the leucite-bearing rock samples show that thei potash content ranges from 7.99 per cent to 11.91 per cent, averagin for nine analyses 10.74 per cent and for the eight samples of wyomingite and orendite, the igneous rocks containing the largest amoun of potash, 11.08 per cent. Taking 10 per cent as a moderate averag of the content of potash there are stored in the lavas in the Leucit Hills the amounts of leucite-bearing rock and potash indicated i the following table:

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[1] Schultz, A. R., and Cross, Whitman, Potash-bearing rocks of the Leucite Hills, Wyoming: Bu U. S. Geol. Survey No. 512, 1912, 39 pp.

[2] Bull. U. S. Geol. Survey No. 512, 1912, pp. 35–36.

Summary of the available leucite-bearing rock and potash from the several exposures of the Leucite Hills, Wyoming.

	Leucite-bearing rock, in short tons.	Potash (K_2O), in short tons.
Badger Teeth	17,841,105	1,784,110
Black Rock Mesa	157,237,200	15,723,720
Boars Tusk	28,994,384	2,899,438
Cross Mesa	78,732.540	7,873,254
Emmons Mesa	94,630,000	9,463,000
Endlich Hill	206,584	20,658
Hague Hill	376,712	37,671
Hallock Butte	11,450,970	1,145,097
Hatcher Mesa	5,127,300	512,730
Iddings Butte	11,526,932	1,152,693
Matthew Mesa	17,519,690	1,751,969
North Table Mesa	15,192,000	1,519,200
Orenda Mesa	149,976,184	14,997,618
Osborn Mesa	5,697,000	569,700
Pilot Butte	6,080,000	608,000
South Table Mesa	108,774,720	10,877,472
Steamboat Mountain	206,181,800	20,618,180
Table Mountain	4,177,800	417,780
Weed Butte	11,431,980	1,143,198
Zirkel Mesa	1,042,341,276	104,234,127
Total	1,973,496,177	197,349,617

These figures do not take into consideration the rock that occurs in the dikes associated with the volcanic necks and surface flows, nor the material underlying the mesas which has not been estimated in the discussion of the separate exposures. If the volcanic cones on Emmons, Zirkel, and Orenda mesas and Steamboat Mountain represent volcanic conduits or necks similar to the volcanic necks seen at Boars Tusk, Badger Teeth, and Iddings Butte, there is considerable leucite-bearing rock in these localities that has not been included in the estimate. Some idea of the amount of material below the mesa for each conduit may be obtained by comparison with the amount estimated for the portions of the Boars Tusk and Badger Teeth lying below the level of the valley.

The figures in the above table for Pilot Butte are based on a 10 per cent potash content, the amount assumed for all the other localities, whereas in the computations used in the discussion under the heading of Pilot Butte, 8 per cent potash, the result as determined by one analysis of this rock, was used.

GREENSAND MARLS AS A SOURCE OF POTASH.

NEW JERSEY.

Potash is found in river waters, but in smaller quantities than soda (Na_2O). The difference is still greater in ocean water, owing to the fact that the potash for some unknown reason is largely taken up by the sediments, forming glauconite, while the soda is largely held back in solution. This glauconite is an important constituent of the greensand marls of New Jersey.

About 30 years ago the greensand marls of the southern portion of New Jersey were in great demand. On the first geologic map of that State the location of the marl beds was shown, and in some of the earlier reports the deposits were described and numerous analyses given, as well as instructions in the use of the marl. In recent years, however, marl has been supplanted to a large extent by the more highly concentrated artificial fertilizers and is no longer dug extensively.

The following analyses show the composition of the different grades of marl as dug and applied to the soil. The glauconite or greensand in them is of nearly uniform composition, but mixed with it are carbonate, sulphate, and phosphate of lime, quartz sand, sulphide an phosphate of iron, shells, etc. The differences in the kind and quantity of these substances cause wide differences in the appearance c the marl containing them, as well as in its composition and propertie

The following table gives the potash and phosphoric acid content in percentages, of typical specimens of New Jersey marl:

Potash and phosphoric acid in typical greensand marl of New Jersey.

	1	2	3	4	5	6	7	8	9	10
Phosphoric acid	1.14	1.33	1.02	2.24	2.69	2.56	3.58	3.87	2.58	2.
Potash	3.65	5.67	6.32	5.18	6.31	4.62	3.75	4.11	4.25	3.

New Jersey marl[1] has been of incalculable value to the region i which it is found. It has raised this region from the lowest state c agricultural exhaustion to a high state of improvement. Found i places where no capital and but little labor were needed to get i the poorest people have been able to avail themselves of its benefit Lands which in the old style of cultivation had to lie fallow, by th use of marl produce heavy crops of clover and grow rich while restin Lands which had been worn out and left in common are now by th use of this fertilizer yielding large crops of the finest quality. Everywhere in the marl district may be seen farms which in former yea would not support a family, but which are now making their owne rich through their productiveness. Bare sands by the applicatio of marl are made to grow clover and then crops of corn, potatoes, an wheat. "Pine barrens" by the use of marl are made into fruitf land. The price of land in the greensand-marl belt of New Jerse was considerably below that in the northern part of the State 4 years ago; now that the lands are improved their price is higher tha that of lands in the northern part of the State.

KENTUCKY.

The Leitchfield marls of Kentucky have been described by Shaler and have been analyzed by Robert Peter.[3] A sample of the Leitchfield marl from a point near Leitchfield, Grayson County, was ser to the United States Geological Survey by M. H. Crump, of Bowlin Green, Ky. It was analyzed in the Survey laboratory by Chas Palmer and found to contain 3.73 per cent potash (K_2O) and 0.1 per cent phosphoric acid (P_2O_5).

Marls approximating this composition are found in large quantiti over a considerable area in west central Kentucky, and in the repor cited above their use was suggested to rejuvenate the lands of tl State worn out as a result of the excessive cultivation of tobacco an other crops requiring large amounts of potash. It is of interest t note here that, among other methods, Peter suggested a method c setting free the alkalies by means of calcium chloride and carbonat of lime, a process referred to in an earlier part of this report.

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[1] Ann. Rept. State Geologist New Jersey, 1886.
[2] Rept. Kentucky Geol. Survey, new ser., vol. 3, 1877, pp. 46–47.
[3] Kentucky Geol. Survey. Chem. analyses, vol. A, 1884 pp. 250–254.

TENNESSEE.

The greensands of Tennessee were mentioned by G. Troost as early as 1835. They are found in Hardin, McNairy, and Henderson counties. The following analyses by Troost are of the greensands of McNairy County:

Analyses of greensand, McNairy County, Tenn.[a]

	1	2	3
Silicas (SiO_2)	48.00	45.30	51.70
Alumina (Al_2O_3)	7.00	6.20	6.50
Ferrous oxide (FeO)	20.70	18.00	21.20
Potassa (K_2O)	10.10	10.40	11.30
Carbonate of lime ($CaCO_3$)	5.70	10.80	2.00
Water (H_2O)	8.00	8.50	7.30
Loss	.50	.80	.00
Total	100.00	100.00	100.00

[a] Safford, J. M., Geol. Survey Tennessee, Nashville, 1869, p. 515.

Phosphoric acid, which is doubtless present in the marls, does not appear to have been separated. The amount of potash in these analyses seems excessive. It probably includes other material.

METHOD OF EXTRACTING POTASH FROM GREENSAND MARLS.

A recent patent by E. C. Eckel (No. 1011172, dated Dec. 12, 1911) contains the description of a process of obtaining potash from greensand. According to Eckel, greensand as a source of potash salts has many advantages over feldspar. It occurs in large quantity in the form of thick beds and in granular condition, and is therefore readily available. It contains a larger content of potash than some igneous rocks and can be decomposed by simply heating either with or without reagents. The cost of feldspar, on the other hand, is greater than that of greensand, since it has to be blasted out of igneous rock and carefully separated before treatment.

In the simplest form of the process outlined the greensand is heated, either with or without being purified, in a suitable kiln to a temperature of about 900° C. The potash is thereby volatilized and is conducted to and condensed in a suitable chamber as potassium hydrate. Modifications of this procedure are suggested, such, for example, as the addition of pyrite, gypsum, lime, or limestone. These assist the chemical action, and volatilization of the potash salts takes place at a lower temperature. The potash salts not passing off may be recovered from the residue by leaching.

KELP AS A SOURCE OF POTASH SALTS.

PRIVATE INVESTIGATIONS.

The occurrence of potash salts in large amounts in kelp has been known for many years. The experiments by David M. Balch[1] on the Pacific coast kelps began early in 1905. Since then the work has been taken up by the Bureau of Soils, Department of Agriculture.

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[1] Jour. Ind. and Eng. Chemistry, vol. 1, No. 12, 1909, pp. 777-787.

Balch gives in the article cited a concise description of the range, relative abundance, life habits, and chemical composition of the three most prominent giant kelps of the Pacific coast. He considers also their economic value and the practical methods of utilizing their products.

In the utilization of kelp on a commercial scale, two factors are of prime importance: (1) The gathering and handling of the material; (2) the extraction from it of its valuable potash salts and other material. A steam scow or launch is suggested for the first operations. Freshly lifted from the sea the kelp contains 80 to 95 per cent moisture and is heavy, bulky, and unmanageable. Drying by artificial heat is preferable. If the material is to be transported after drying, the latter process should be stopped just as soon as the efflorescence of of salts appears. The material then remains soft and pliable and can be compressed into small space. If drying is carried too far, the material becomes tough and elastic, and considerable loss results from handling. When properly dried, the kelp contains 15 per cent water and 40 to 50 per cent of chlorides, sulphates, and other salts. For the recovery of these latter the dry distillation of the kelp is suggested in which the charred kelp saturated with mineral salts is the most important product. According to Balch, 1 ton of thoroughly air-dried kelp may be depended upon for a minimum yield of 500 pounds pure potash salts and 3 pounds of iodine, not to mention the other valuable by-products.

The Coronado Chemical Co. was incorporated in 1906 for the purpose of treating kelp according to a process invented by the late Henry S. Firman. It is a significant fact that although this company has been engaged in developing this process six years, no output of potash salts has been marketed up to the present time. The details connected with the plant are described on a subsequent page.

INVESTIGATIONS BY BUREAU OF SOILS.

During the spring and summer of 1911 work on the Pacific coast kelps was inaugurated by the Department of Agriculture. A recent editorial by F. K. Cameron[1] gives some of the results obtained. Cameron's later and complete report[2] goes into the investigations in great detail, and is most comprehensive, as will be seen from the following chapters included in it:

Memorandum in re jurisdiction over kelp groves.
The kelps of the United States and Alaska, by William A. Setchell.
Ecological and economic notes on Puget Sound kelps, by George B. Rigg.
The kelps of the central Californian coast, by Frank M. McFarland.
The kelps of the southern Californian coast, by Capt. W. C. Crandall.
Brief notes on the kelps of Alaska, by Edward C. Johnston.
The composition of kelps, by J. W. Turrentine.
The technology of the seaweed industry, by J. W. Turrentine.
A discussion of the probable food value of marine algæ, by C. L. Alsberg.
Reference lists of publications relating to marine algæ, their economic uses, and the salts derived from their ashes.

The report is illustrated with plates showing various phases of the kelp industry and with maps showing portions of the Pacific coast, where the kelps occur.

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[1] Jour. Ind. and Eng. Chemistry, February, 1912, pp. 76-77.
[2] A preliminary report on the fertilizer resources of the United States: S. Doc. 190, 62d Cong., 2d sess.

The following notes have been compiled from the report:

VARIETIES OF KELP.

The principal kelp of Puget Sound is the *Nereocystis luetkeana*, known commonly as the bladder or bull kelp. This is in this region the only variety probably which will justify harvesting. The second in importance in the Puget Sound region is Macrocystis. In the vicinity of Monterey, Nereocystis is abundant, but the main kelp is *Macrocystis pyrifera*. From Point Sur south to Magdalena Bay, extensive and, in some places, very dense groves of kelp occur of which the most important variety is *Macrocystis pyrifera*, the second in importance being *Pelagophycus porra*, with other varieties negligible, economically considered.

SURVEY OF KELP GROVES.

A fair but conservative estimate of the weight of kelp surveyed in Puget Sound is more than 200,000 tons, but it is reported that a complete survey would add to this tonnage. The Puget Sound kelps occur wherever there is a rocky bottom to which the holdfasts may anchor and where also the salt water is constantly in motion, as for example, in the tideways. It was found difficult to estimate the tonnage of kelp near Monterey but the amount probably lies between 80,000 and 100,000 tons. No definite statement can be made as to how much more will be added to these figures by detailed surveys. It is stated in the report that the kelp groves are small until Point Sur is reached and the suggestion is made that it may prove more desirable to use the kelp locally as manure than to attempt the preparation of commercial fertilizers from it. From Point Sur south to Magdalena Bay, 85 square miles of kelp groves were surveyed, of which 20 square miles are of very heavy growth. The area surveyed was probably not half the area of groves from Point Sur to the Mexican line and certainly less than a quarter of all the groves from Point Sur to Magdalena Bay. The groves in this southern region are on the exposed shore of the main land and islands where there is a rocky bottom and continual movement of water. Macrocystis occurs at depths of 6 to 10 fathoms and Pelagophycus in deeper water, namely 12 to 18 fathoms. In all, 8,000,000 tons of kelp were surveyed during the summer.

COMPOSITION OF KELP.

Analyses have been made of oven-dried samples of the principal varieties of kelps from Puget Sound, the coast near Monterey, and the coast near San Diego. A few specimens from Alaska have also been examined. The average of seven samples of the principal varieties shows the Puget Sound kelps to contain 30 per cent potassium chloride and 0.16 per cent iodine; the average of six samples from Monterey shows 31 per cent potassium chloride and 0.18 per cent iodine; and the average of 30 samples from San Diego shows 23 per cent potassium chloride and 0.29 per cent iodine. It is doubtful if there is any essential difference in the yield of potash between the northern and the southern kelps. The latter apparently are richer in iodine than the northern kelps.

HARVESTING THE KELP.

It has been stated that the principal kelp of the Northern Pacific is the *Nereocystis luetkeana.* This plant is an annual and its cutting and gathering will have to be carried out with care, if its yearly growth is to be maintained and the plant not soon completely destroyed. Rigg suggests it would be best to harvest it not sooner than July 15. Further investigations will have to be made on the Alaska kelps to determine the proper time for their harvesting. With Macrocystis the case is different. This plant is probably a perennial; at least it lives more than one year. It is claimed that if the fronds alone of this plant are cut away and the stipes and holdfasts not seriously disturbed, the plant will reproduce as heavy a growth in 40 to 60 days as before cutting.

The cutting and gathering of the kelp has not yet been satisfactorily worked out. "The problem is a purely mechanical one, with no theoretical difficulties, so far as can be seen. It is reasonably certain that American ingenuity will solve the problem. It can hardly be considered even a serious one in forecasting the possibilities of a kelp industry."

SUBSEQUENT TREATMENT OF KELP.

The final step in obtaining the potash salts is the treatment of the kelp after it has been gathered. Limited experience has proved that burning in ovens or retorts yields better results than burning in piles on the shore. In Europe the latter method has been used, but it has resulted in loss of potash salts and iodine. Oil is preferable as a fuel, and this is present in abundance and at a low cost on the Pacific coast. When burned in closed retorts there is produced a mixture of heating and illuminating gases which can be made use of in various ways. The tar and oil products and the charcoal will also prove to be by-products of value. If the heating is not carefully carried out the substances are liable to melt and cake badly, to prevent which infusible substances like rock phosphate, lime, etc., may be added. When the properly burned melt is lixiviated and the mother liquor evaporated potassium chloride crystallizes out in fairly pure form. The mother liquor remaining contains a mixture of salts, among which are the chlorides and sulphates of sodium and magnesium. Iodides are also present. For the recovery of the iodine several of the common methods are suggested.

CONCLUSIONS.

The available data, according to Cameron, are not sufficient to make an accurate forecast or even a close approximation to the possible future value of the kelp industry. Figures are cited, however, showing what are considered the limits between which the probably true value of the industry lies. For these figures the reader is referred to Senate Document 190.

The tonnage of kelp actually seen and mapped during the summer of 1911 contains considerably more than the equivalent of our present importations of potash salts. Excluding the kelp that may be found in Alaska waters, it is probable that less than a fourth of the standing kelp was mapped. Considering the probability that a majority o the groves could be safely cut twice a season, it appears that the yield of potash salts may greatly exceed our present needs. The recoverable iodine is also greatly in excess of the present consumption of this chemical in the United States.

SIMPLE FIELD AND LABORATORY TESTS FOR POTASH.

The following data on the simpler qualitative and quantitative analytical methods of testing for potash salts are by H. S. Gale.[1]

The flame and spectroscope methods are the simplest and the only ones that can be cited in reply to the numerous inquiries asking for a simple field or laboratory test.

FLAME COLORATION.

The color often imparted to the outer blowpipe flame, while the mineral held in the forceps is being heated, makes possible the identification of a number of the elements. Potash imparts a violet color to the flame when alone. It is best detected in small quantities, or when soda or lithia is present, by the aid of the spectroscope.

The presence of soda, even in small quantities, produces a yellow flame which (except in the spectroscope) more or less completely masks the coloration of the flame due to other substances—for example, potassium. The use of a wedge of blue glass then allows the characteristic violet color to be observed. Silicates are often so difficultly decomposed that no distinct color is obtained even when the substance is present. In such cases (for example, potash feldspar) the powdered mineral may be fused on the platinum wire with an equal volume of gypsum, when the flame can be seen (at least through blue glass).

The material in solution or as a powder may also be heated on a platinum wire to get the flame-coloration test.

A very convenient and rapid method for close approximate quantitative tests with the small hand spectroscope is in use at the laboratory at Fallon.

The quantitative determination of potassium spectroscopically is described in some detail in a paper by Gooch and Hart.[2] The suggestion that this method could be conveniently adapted for field-laboratory use and that sufficiently close approximations could be obtained in a rather rough application of the method, which would serve the immediate requirements of the preliminary field tests, was made by W. D. Collins, of the Bureau of Chemistry, Department of Agriculture. The method is especially adapted to the detection and determination of very small amounts of potassium. As a large number of the samples submitted for tests contain commercially unimportant percentages of potassium, these may be at once eliminated. Larger amounts of potassium, however, can be approximated with sufficient accuracy to serve commercial requirements.

Reduced to simplest terms the method in use at Fallon may be described as follows: A given amount (say 1 gram) of a salt to be tested, previously pulverized, is placed in a graduated cylindrical glass, and sufficient distilled water added to take up all the soluble portion of the sample. For example, it may be assumed that the glass is filled up to the 10 cubic centimeter mark; then each cubic centimeter of this solution contains one-tenth of the total readily soluble matter of the original 1-gram sample. This solution is tested by volatilizing a small portion on a platinum wire before the spectroscope and observing the direct spectrum for the characteristic potassium line. The spectroscope is set up with a flame of given heat intensity in a fixed position before it. A coil of platinum wire is mounted in a glass-rod handle, with which a uniform amount of solution can be dipped and after careful drying can be volatilized in the flame on the side next the aperture of the spectroscope. The platinum wire may be freed from traces of potassium before the test by immersing it in hydrochloric acid and heating it in the flame.

If by trial of the solution prepared as described above the potassium line is found to be readily observed, then water is added to the solution of the unknown, increasing the dilution until a point is reached at which the potassium line from a single wire coil full of the solution can no longer be detected. The volume of the solution at which the test was last obtained is then recorded. To carry out the example, it may be assumed that this point was reached when the solution had been brought up to a volume of 80 cubic centimeters. It is therefore necessary to revert to a standard that should be established for the particular conditions under which the test is made. Let it be supposed that a series of solutions has been prepared as follows: No. 1 contains 1.91 grams of potassium chloride (equivalent to 1 gram of potassium) made up to 100 cubic centimeters (or grams) of water; each cubic centimeter of this solution therefore contains 0.01 gram of potassium. No. 2 contains the same quantity of potassium chloride made up to 1,000 cubic centimeters (or grams) of water; each cubic centimeter of this solution therefore contains 0.001 gram of potassium. No. 3 and other solutions are made up in greater or in a more complete series of intermediate dilutions.

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[1] Bull. U. S. Geol. Survey No. 530-A, 1911, pp. 21–24.

[2] Gooch F. A., and Hart, T. S., The detection and determination of potassium spectroscopically: Am. Jour. Sci., 3d ser., vol. 42, 1891, pp. 448–459.

The spectroscope and vaporizing lamp having been set up, solution No. 1 is volatilized on the prepared coil of platinum wire before the spectroscope, the spectrum being carefully watched for the appearance of the potassium line. Presumably it will show distinctly. Solution No. 2 is treated similarly, and it is possible that if the instrument used is a small one and the conditions of light not the most favorable, the potassium line may be observed but very faintly.[1] It may be assumed, for the sake of this example, that greater dilutions are found to give a negative test. Therefore the standard obtained for these circumstances will be that solution No. 2 is the minimum dilution that can be recognized in the spectrum and is equivalent to 0.001 gram of potassium for each cubic centimeter of the solution.

To return to the unknown that was being tested: A 1-gram sample had been diluted to 80 cubic centimeters, beyond which the spectrum test could not be recognized. Therefore it may be assumed that each cubic centimeter of the unknown solution contains 0.001 gram of potassium, and that the original 1-gram sample submitted for test contained 0.08 gram of potassium. The potassium content of the unknown salt is therefore 8 per cent. If the vanishing point of the spectrum line can be determined with certainty within the range of 70 to 90 cubic centimeters dilution as described above, the result is probably accurate within 1 per cent. This is all that is required for most commercial purposes. It is believed that this degree of accuracy may be maintained under ordinary conditions, although it is readily seen that this method is most accurate when used on material containing only small amounts of potassium.

FIELD TEST FOR ALUNITE.[2]

The following simple field test for the mineral alunite has been suggested by W. T. Schaller: Boil the powdered sample with water or with hydrochloric acid for several minutes; after allowing the powder to settle pour off the liquid and repeat the operation to insure the removal of all soluble sulphates. Dry the powder and heat to a dull red. Again boil in water and, after settling, pour off some of the clear liquid. To this add a small fragment or a solution of barium chloride. If the mineral is alunite a heavy white precipitate will form. To be sure that the water used in this test does not contain sulphates in solution it should be tested with barium chloride, and if it gives a marked precipitate it can not be used. For this test all that is required that is not included in a miner's or prospector's outfit is a little barium chloride, which can be carried in a small bottle or cartridge.

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[1] Hand spectroscopes are to be had from most dealers in laboratory apparatus at prices ranging from $7 upward.

[2] Bull. U. S. Geol. Survey No. 511, 1912, p. 63.

THE CONSUMPTION OF POTASH SALTS IN THE UNITED STATES.

In the following table there is given the importation of potash salts in pounds for the calendar years 1901, 1905, 1909, 1910, and 1911:

Potash salts imported into the United States for the calendar years 1901, 1905, 1909–1911, in pounds.[a]

	1901		1905	
	Quantity.	Value.	Quantity.	Value.
Potash:				
Carbonate of				
Caustic or hydrate of, not in sticks or rolls				
Cyanide of [b]				
Chloride of	144,189,337	$2,316,577	214,207,064	$3,326,478
Nitrate of, or saltpeter, crude	9,600,393	251,783	9,911,534	304,596
Sulphate of				
All other [c]	73,301,040	1,698,204	82,935,532	1,891,081
Total	227,090,770	4,266,564	307,054,130	5,522,155

	1909		1910		1911	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Potash:						
Carbonate of	21,023,695	$692,822	18,963,619	$616,371	20,765,990	$636,356
Caustic or hydrate of, not in sticks or rolls	8,163,128	339,564	8,304,696	346,388		
Cyanide of [b]					[d] 2,113,684	[d] 316,027
Chloride of	298,854,649	4,780,106	381,873,875	5,252,373	509,254,846	7,655,965
Nitrate of, or saltpeter, crude	14,883,849	437,690	11,496,904	333,854	7,812,092	260,780
Sulphate of	70,161,832	1,301,205	86,162,874	1,426,975	121,039,192	2,227.820
All other [c]	[d] 998,685	[d] 133,801	3,389,684	387,662	4,583,940	442,042
Total	414,085,838	7,685,188	510,191,652	8,363,623	672,639,581	11,826,106

[a] This table is based on total imports for the calendar year, not, as nearly all the import tables in this volume, on imports for consumption for the calendar year.

[b] Included in "All other chemicals" prior to July 1, 1911.

[c] Included in "All other chemicals" prior to July 1, 1909.

[d] Figures cover period since July 1.

The importation of potash salts given in this table is only a part of that entering the United States from Germany. To it should be added the importation of kainite and manure salts. The importation of fertilizers, including kainite and manure salts, is given in the following table:

Total fertilizers imported into the United States for the years ending Dec. 31, 1901, 1905, 1909–1911, in long tons.[a]

	1901		1905	
	Quantity.	Value.	Quantity.	Value.
Fertilizers:				
Guano	6,252	$74,670	25,651	$365,823
All other		2,375,938		4,324,292
Total		2,450,608		4,690,115

[a] This table is based on total imports for the calendar year and not, as nearly all the import tables in this volume, on imports for consumption for the calendar year.

Total fertilizers imported into the United States for the years ending Dec. 31, 1901, 1905, 1909–1911, in long tons—Continued.

	1909		1910		1911	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Fertilizers:						
Bone dust and bone ash[a]	....	....	....	....	[b] 17,818	[b] $429,195
Guano	37,766	$734,636	44,268	$699,949	35,869	774,313
Kainite[c]	....	....	[b] 377,778	[b] 1,868,304	[b]258,666	[b] 1,340,040
Manure salts[c d]					479,186	3,103,262
All other	....	5,770,454	....	6,870,164	....	5,175,539
Total	....	6,505,090	....	9,438,417	....	10,822,349

[a] Included in "All other fertilizers" prior to July 1, 1911.
[b] Figures cover period since July 1.
[c] Included in "All other fertilizers" prior to July 1, 1910.
[d] Includes kainite prior to July 1, 1911.

It will be observed in this table that the kainite and manure salts imported from Germany are not listed as such in the years 1901, 1905, and 1909. For these years they are included in the fertilizer listed under "all other." They are lumped for the year 1910, but during that year the figures given are those for only the last six months. For the year 1911 it will be noted that the figure for kainite is that for only the last six months of the year. However, the importation of this commodity for the first six months of that year is included under manure salts. The total importation of potash salts in 1911 was valued at $16,269,408; this includes potash salts imported as such ($11,826,106), kainite ($1,340,040), and manure salts ($3,103,262).

The corresponding figure for 1901 can not be given for the reasor that the importations of kainite and manure salts are not listed a such for that year, hence a strict comparison between the tota amount of potash salts imported in 1901 and the amount importec in 1911, a decade later, can not be made. In the case of pure potasl salts, however, the increase during these 10 years amounted in valu to $7,559,542, or 177 per cent, and in quantity to 395,548,811 pounds or 143 per cent.

In this connection the following recent statement prepared by th Bureau of Statistics is of interest:

> The importation of potash salts is now running at the rate of over a million dollar a month, and has aggregated since 1900 approximately $75,000,000. While thes potash salts enter the country in various forms and thus under various titles, includin muriate of potash, sulphate of potash, carbonate of potash, kainite, etc., their aggre gate import value in the 9 months ending with September, 1911, was $11,500,00 against about $7,000,000 in the corresponding months of 1910, and a little ove $5,000,000 in the corresponding months of 1909, thus indicating a steady and rapi growth in the importation of this class of products. Taking the figures for fiscal year the total for 1911 was $14,000,000, compared with less than $12,000,000 in 1910, le than $4,000,000 in 1900, and less than $2,000,000 in 1890.

MATERIALS ENTERING LARGELY INTO THE FERTILIZER INDUSTRY IN THE UNITED STATES.

In the following table is given the statistics of materials entering largely into the fertilizer industry in the United States:

Materials entering largely into the fertilizing industry in the United States for the years ending Dec. 31, 1901–1911, in long tons.

	1901		1905	
	Quantity.	Value.	Quantity.	Value.
Imported:				
Fertilizers	....	$2,450,608	....	$4,690,115
Potassium chloride	64,370	2,316,527	95,628	3,326,478
Potassium sulphate	....	....	....	....
Sodium nitrate (Chile saltpeter)	208,679	5,999,098	321,231	11,206,548
Domestic phosphate rock	1,483,723	5,316,403	1,947,190	6,763,403
Total	....	16,082,636	....	25,986,544

	1909		1910		1911	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Imported:						
Fertilizers	....	$6,505,090	....	$9,438,417	....	$10,822,349
Potassium chloride	133,427	4,780.106	170,479	5,252,373	227,346	7,655,965
Potassium sulphate	31,322	1,301,205	38,466	1,426,975	54,035	2,227,820
Sodium nitrate (Chile saltpeter)	428,429	13,608,195	529,172	16,601,328	544,878	16,814,256
Domestic phosphate rock	2,330,152	10,772,120	2,654,988	10,917,000	[a] 3,030,000	[a] 11,870,000
Total	....	36,966,716	....	43,636,093	....	49,390,390

[a] Estimated.

This table requires some explanation. In the first place, the imports given in it are "general imports" (as also in the two preceding tables) and not "imports for consumption." General imports are those entered at the customhouse for immediate consumption, and imported articles entered for the warehouse but not necessarily removed therefrom for consumption, and hence, strictly speaking, not necessarily consumed in the year under which they are given. This, however, does not destroy the value of comparisons between different years. In the second place, all the sodium nitrate reported is not used in the fertilizer industry. A large part of it is converted into nitric acid and potassium nitrate, the latter being used for making gunpowder and other explosives, matches, pyrotechnics, in assaying, in metallurgical and analytical operations, for curing meat, etc. The magnitude of the importation of this material is, however, very significant. This sodium nitrate is another commodity for which the United States is entirely dependent on a foreign country. Lastly, it is probable that not quite all the potassium chloride and potassium sulphate are used in the fertilizer industry.

DOMESTIC POTASH SALTS INDUSTRY.

APPLICATIONS.

Potash salts are used extensively in the United States. They are essential to numerous industries that are vitally connected with the welfare of the American people—the most notable being the fertilizer industry. They are used also in the manufacture of glass, in certain kinds of soap, in explosive powders, and in the chemical industries, including the manufacture of alum, cyanides, bleaching powders, dyestuffs, and other chemicals, among which are arsenite of potassium, bromide of potassium, chlorate of potassium, permanganate and manganate of potassium, nitrate of potassium, silicate of potassium, etc.

DOMESTIC PRODUCTION FROM WOOD ASHES.

Practically all potash salts of mineral origin consumed in the American industries at present are imported from abroad, chiefly from Germany. There was a time in the history of the potash industry, however, when the United States produced a large part, if not all, of the potash it consumed. The burning of wood and the lixiviation of the resulting ash to extract the potash, though of minor importance so far as the monetary value of the product is concerned, is one of the oldest of the purely chemical industries in this country. Cognizance was taken of it in the census reports as early as 1850, so that data are available for comparing the condition of the industry for each decade since that year. In the following table are given the quantity and value of potash produced in the United States from 1850 to 1910:

Potash salts produced in the United States, 1850 to 1910.[a]

	Number of establishments.	Product.		Average price per pound.
		Quantity in pounds.	Value.	
1850	569	....	$1,401,533	....
1860	212	....	538,550	....
1870	105	....	327,671	....
1880	68	4,571,671	232,643	$0.05
1890	75	5,106,939	197,507	.03
1900	67	3,864,766	178,180	.04
1905	39	1,811,037	104,655	.05
1910	30	1,866,570	88,940	.04

[a] Munroe, C. E., Bull. 92, Census of Manufactures, Bur. Census, 1908, p. 38. The figures for 1910 were kindly furnished by the Bureau of the Census.

DOMESTIC PRODUCTION FROM KELP.

A plant for the extraction of potash salts from kelp has been established at the station of Cardiff, about 30 miles north of San Diego Cal., on the Atchison, Topeka & Santa Fe Railway, and a short distance from the ocean beach. The plant is owned by the Coronado Chemical Co. (Arthur H. Firman, president), incorporated in 1906 fo the purpose of perfecting and exploiting a process of treating kelp invented by the late Henry S. Firman.

The present plant consists of four furnaces, each being capable o incinerating 6,000 pounds of dried kelp every 24 hours. Two add tional furnaces are under construction, so that the entire plant wi have a capacity of treating 18 tons of dried kelp per day. Each to of dried kelp will yield one-half ton of clinker, or "char," said to carr from 20 to 30 per cent K_2O. The plant is of substantial constructio and including building, equipment, harvesting apparatus, and 9 acres of ground, represents an actual investment of approximatel $75,000. The year 1912 will probably show a substantial output o potash in the United States, outside of that obtained from wood ashe Although for six years this company has been actively engaged i developing its process, no output of potash has as yet been markete

The plant was visited by Edward W. Parker, of the United States Geological Survey, the latter part of February of the present year (1912). At that time the company expected to begin commercial operations about March 1.

THE CHEMICAL MANUFACTURES IN THE UNITED STATES DEPENDENT ON IMPORTED POTASH SALTS.

The chemical industries in the United States dependent on potash salts are of enormous magnitude. A list of these industries has already been given on pages 911–912, under "Applications." Further details relating to these industries are given in the following pages, together with the statistics of their production, wherever it was possible to obtain them.

Potash.—Under the head of potash are included potassium carbonate and caustic potash. The former was for a long time the best known potash salt, being the residue from boiling lye from wood ashes in iron pots, whence the name potash. Potassium carbonate is now almost entirely made from potassium chloride by the LeBlanc process, in the same way as soda ash from salt, but the ammonia process can not be employed, because the acid carbonate of potassium ($KHCO_3$) is soluble in ammoniacal solutions and does not precipitate. The material is sold in the trade under the name potash or pearlash and is used chiefly in the glass industry, in the manufacture of caustic potash, and in the manufacture of chromates of potassium. A considerable quantity is bought by soap makers and causticized, the solution being used for soft soaps.

Caustic potash (KOH) is made in a similar manner to caustic soda. It is much more deliquescent than the corresponding sodium compound and is generally made where it is to be used. In soap making it was formerly customary to saponify the fat with caustic potash and then to add common salt. An interchange between the potassium and sodium took place, the result being a hard sodium soap. But as soda is now cheaper than potash and yields a hard soap directly, potash soaps are used only for special purposes. The magnitude of the industries using this class of potash salts may be judged by the importations given in the table on a preceding page.

Alums.—In the manufacture of potash alum ($K_2SO_4.Al_2(SO_4)_3.24H_2O$) large quantities of potassium sulphate are used. On the addition of the potassium sulphate to the sulphate of alumina the potash alum crystallizes out in extremely pure form. Alum is extensively used in the dyeing industry as a mordant and by paper makers and leather dressers. It is also used in making pigment lakes, clarifying turbid liquids, and precipitating sewage, and for hardening plaster of Paris casts, etc. A small quantity is used in medicine. The following table gives the quantity and value of potash alum manufactured in the United States at the censuses of 1899, 1904, and 1909:

Potash alum manufactured in the United States, 1899, 1904, and 1909.

	Quantity.	Value.
	Pounds.	
1889	14,200,393	$215,004
1904	10,307,154	156,448
1909	10,253,802	155,319

Cyanides and derived compounds.—The cyanides comprise potassium cyanide; sodium cyanide and other simple cyanides, including "cyan-salt," a mixture of potassium and sodium cyanides; potassium ferrocyanide (yellow prussiate of potash); potassium ferricyanide (red prussiate of potash). There are also the cyanates and ammonium and potassium sulpho-cyanates, etc.

Potassium cyanide (KCN) is generally made by fusing potassium ferrocyanide with potassium carbonate until the evolution of gas ceases. The following is the reaction:

$$K_4Fe(CN)_6 + K_2CO_3 = 5KCN + KCNO + CO_2 + Fe.$$

The metallic iron that is produced sinks to the bottom of the crucible, and the fused mixture of cyanide and cyanate is run off. The addition of powdered charcoal reduces part of the cyanate to cyanide. The product thus prepared is pure enough for many purposes. The commercial salt always contains cyanate and carbonate and is sold in various grades, depending on the purpose for which it is to be used. The best quality contains about 98 to 99 per cent KCN, but ordinary grades contain only 65 to 70 per cent. It is a very powerful reducing material when heated with reducible substances, and hence its use as a flux. It is extremely poisonous, either when taken internally or when introduced directly into the blood. It is extensively employed in electroplating as the solvent in the bath, forming soluble double cyanides with gold, silver, copper, and other metals. It is also used as a flux in assaying and metallurgy. Its greatest use at the present time is for the recovery of gold from low-grade ores and the tailings of other reduction processes. A weak solution is used to dissolve the gold, forming aurous potassium cyanide (AuCN.KCN). It was formerly used in photography for "fixing" the image, but for this purpose it has been largely replaced by sodium thiosulphate.

Potassium ferrocyanide ($K_4Fe(CN)_6.3H_2O$), also called yellow prussiate of potash, is made by fusing together potassium carbonate, iron borings, and nitrogenous organic matter of any kind, such as horn, hair, blood, wool waste, and leather scraps. The material in its pure form is produced in splendid large lemon-yellow crystals. It is not poisonous. It is largely used for making Prussian blue; in calico printing and in dyeing; for case-hardening iron; for making potassium cyanide and ferricyanide; and to a small extent in explosives and as a chemical reagent.

Potassium ferricyanide, or red prussiate of potash (K_3FeCN_6), is usually made by passing chlorine gas into a solution of the ferrocyanide until ferric chloride no longer forms a precipitate, but produces only a brown color in the liquid. It may also be made by exposing the dry powdered ferrocyanide to chlorine until a test portion dissolved in water gives nothing but a brown color, with ferric chloride. With ferrous salts, it gives the blue pigment Turnbull's blue. Its solution with caustic potash is a powerful oxidizing liquid and as such is used in calico printing for a "discharge" on indigo and other dyes. It also forms part of the sensitive coating of blueprint papers. It has been recommended for use with potassium cyanide solution in gold extraction.

The following table shows the magnitude of the cyanide industry in the United States at the censuses of 1899, 1904, and 1909:

Cyanides manufactured in the United States, 1899, 1904, 1909.

	1899	1904	1909	Increase.		Percentage of increase.	
				1899 to 1904	1904 to 1909	1899 to 1904	1904 to 1909
Quantity, pounds	8,460,989	11,196,318	13,291,080	2,735,329	2,094,762	32.3	18.7
Value	$1,595,505	$1,710,823	$1,941,893	$115,318	$231,070	7.2	13.5
Value per pound	$0.189	$0.153	$0.146	....	....	....	....

Fertilizers.—The fertilizers comprise numerous chemical compounds, among them the so-called complete fertilizers, which consist of superphosphate of lime, potash salts, and ammoniacal or other nitrogenous compounds, including nitrates. The following table gives the quantity and value of complete fertilizers manufactured in the United States at the censuses of 1899, 1904, and 1909, together with the amount and percentage of increase. Compared with 1904 the increase in 1909 amounted to nearly 84 per cent in quantity and to nearly 100 per cent in value.

Complete fertilizers manufactured in the United States, 1899, 1904, 1909.

	1899	1904	1909	Increase.		Percentage of increase.	
				1899 to 1904	1904 to 1909	1899 to 1904	1904 to 1909
Quantity, short tons	1,478,826	1,603,847	2,949,083	125,021	1,345,236	8.4	83.9
Value	$26,318,995	$31,305,057	$62,050,731	$4,986,062	$30,745,674	18.9	98.2

The following table gives the quantity and value of the principal potash materials used in fertilizers in the United States at the three censuses cited, with the amount and percentage of increase. This table includes only the materials used in the principal establishments in the United States. The increase in the quantity and value of kainite and potash salts used in the manufacture of fertilizers in 1909 as compared with 1904 is notable.

Principal potash materials used in fertilizers in the United States: 1899, 1904, and 1909.

	1899	1904	1909	Increase.		Percentage of increase.	
				1899 to 1904	1904 to 1909	1899 to 1904	1904 to 1909
Kainite:							
Quantity, short tons	54,700	190,493	347,104	135,793	156,611	248.3	82.2
Value	$520,833	$1,891,070	$3,008,183	$1,370,237	$1,117,113	263.1	59.1
Potash salts:							
Quantity, short tons	....	[a] 123,267	269,979	....	146,712	....	119.0
Value	[b] $3,130,556	$3,645,740	$7,708,542	$515,184	$4,062,802	16.4	111.4

[a] Includes nitrate of potash amounting to 1,160 tons, valued at $39,039.
[b] Includes nitrate of potash to the value of $32,156.

Bleaching materials.—The class of bleaching materials include among a great many other chemicals, potassium bisulphite. Potas sium bisulphite forms a very small part of the total. The followin table gives the quantity and value of bisulphites manufactured i the United States at the censuses of 1899, 1904, and 1909, with th amount and percentage of increase:

Sodium, potassium, calcium, and other bisulphites manufactured in the United State 1899, 1904, and 1909.

	1899	1904	1909	Increase.		Percentage of increase.	
				1899 to 1904	1904 to 1909	1899 to 1904	1904 to 1909
Quantity, short tons	1,461	6,223	8,119	4,762	1,896	325.9	30.
Value	$34,486	$110,155	$445,371	$75,669	$335,216	219.4	304.

Potash salts consumed in manufacture of electrochemicals.—Th figures given in the following table for potash salts in 1899 and 190 are for the quantity and cost of potassium salts consumed as materia in the manufacture of electrochemicals and not for the potash salt made electrolytically. Statistics are not available for the electrolyti production or for the quantity and cost of potash salts consumed a raw material in 1909.

Potash salts consumed in manufacture of electrochemicals in the United States, 189 and 1904.

	1899	1904	Increase.	Percentage of increase.
Quantity, short tons	1,900	3,908	2,008	105.7
Value	$80,097	$200,008	$119,911	149.7

Dyestuffs.—Potash salts enter into the dyeing industry chiefly in the form of alum. The production of alum has already been given and will not be repeated here. Potassium sulphide is frequently used to improve the "fire" in vermilion. Potassium bichromate is extensively used in the manufacture of chrome green.

Explosives.—Potash salts in the form of nitrate enter into the manufacture of gunpowder. The term "gunpowder" generally includes the nitrate-sulphur-charcoal combination used in blasting as well as that used in guns, and for the last 50 years it has included the blasting powder made with nitrate of soda as well as that made with nitrate of potash. Potassium nitrate is also a constituent of some of the higher-grade explosives tested and listed by the Bureau of Mines as "permissible explosives." Potassium nitrate is made by the double decomposition of sodium nitrate with potassium chloride, the former being largely imported from Chile. The reaction ($NaNO_3+KCl=NaCl+KNO_3$) is very simple. The following table gives the quantity and cost of nitrate of potash used in the explosives industry in the United States in the years 1899 and 1904, the figures for 1910 not being available:

Potassium nitrate used in the manufacture of explosives in the United States, 1899 and 1904.

1899		1904	
Quantity.	Value.	Quantity.	Value.
Short tons. 3,315	$270,186	*Short tons.* 4,114	$308,644

General chemicals.—Under the heading of general chemicals potash enters into the composition of a host of substances. Some of these are arsenite of potassium, used in the dyeing industry; bromide of potassium, used in photography and medicine; chlorate of potassium, used in fireworks, matches, and aniline colors; chromate of potassium, used in dyeing and electrical cells; manganate and permanganate of potassium, used in dyeing and bleaching, in disinfectants, and in medicine; silicate of potassium, used in making ordinary yellow soaps, as a fixative for pigments in calico printing, as a vehicle for pigments in fresco painting, for rendering cloth and paper noninflammable, etc.; cream of tartar; and argols.

SALT AND BROMINE.

By W. C. Phalen.

SALT.

PRODUCTION.

The production of salt in the United States, including Hawaii and Porto Rico, in 1911 amounted to 31,183,968 barrels of 280 pounds each, valued at $8,345,692. The corresponding figures for 1910 were 30,305,656 barrels and $7,900,344. Thus the increase in 1911 amounted to 878,312 barrels, or very nearly 3 per cent, in quantity and $445,348, or nearly 6 per cent, in value. The output for 1911 expressed in terms of tons of 2,000 pounds each amounted to 4,365,756 tons against 4,242,792 tons in 1910, an increase during 1911 of 122,964 tons. The average price of salt per barrel in 1911 was 26.763 cents, or $1.91 per short ton, against 26.069 cents per barrel and $1.86 per short ton in 1910.

In the following table are given the quantity and value of salt produced in the United States from 1893 to 1911, inclusive:

Production and value of salt in the United States, 1893–1911.

1893..barrels..	11,897,208	$4,154,668	1903..barrels..	18,968,089	$5,286,988
1894....do....	12,968,417	4,739,285	1904....do....	22,030,002	6,021,222
1895....do....	13,669,649	4,423,084	1905....do....	25,966,122	6,095,922
1896....do....	13,850,726	4,040,839	1906....do....	28,172,380	6,658,350
1897....do....	15,973,202	4,920,020	1907....do....	29,704,128	7,608,323
1898....do....	17,612,634	6,212,554	1908....do....	28,822,062	7,553,632
1899....do....	19,708,614	6,867,467	1909....do....	[1] 30,107,646	8,343,831
1900....do....	20,869,342	6,944,603	1910....do....	[1] 30,305,656	7,900,344
1901....do....	20,566,661	6,617,449	1911....do....	[1] 31,183,968	8,345,692
1902....do....	23,849,231	5,668,636			

PRODUCTION BY GRADES AND STATES.

Production by grades.—The following table shows the salt production of the United States, by grades, during the last five years:

Production of salt, by grades, in the United States, 1907–1911, in barrels.

Year.	Table and dairy.	Common fine.	Common coarse.	Packer's.	Solar.
1907	3,537,157	7,684,638	2,055,054	422,324	862,929
1908	3,202,016	7,388,903	2,550,333	373,284	1,156,034
1909	3,042,824	7,745,204	2,843,393	385,802	1,283,548
1910	3,514,748	6,153,296	2,602,737	327,304	1,223,371
1911	3,773,798	6,267,850	2,970,492	408,928	1,340,440

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[1] Includes production of Hawaii and Porto Rico.

Production of salt, by grades, in the United States, 1907–1911, in barrels—Continued

Year.	Rock.	Other grades.	Brine.	Total production.	Total value.
1907	5,809,328	110,227	9,222,471	29,704,128	$7,439,5
1908	5,161,211	121,065	8,869,216	28,822,062	7,553,6
1909	5,938,721	97,347	8,770,807	30,107,646	8,343,8
1910	6,965,938	129,036	9,389,226	30,305,656	7,900,3
1911	6,225,216	169,833	10,027,411	31,183,968	8,345,6

Production by States.—The following table gives the productio and value of the salt produced in the United States from 1908 to 1911 inclusive, by States:

Production and value of salt, 1908–1911, by States, in barrels.

State.	1908		1909		1910		1911	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
New York	[a]10,023,872	[a]$2,386,471	[a]10,914,255	[a]$2,646,736	[a]11,642,520	$2,585,739	[a]11,234,928	$2,538,151
Michigan	10,194,279	2,458,303	9,966,744	2,732,556	9,452,022	2,231,262	10,320,074	2,633,15
Ohio	3,427,478	864,710	3,684,775	993,700	3,673,850	951,963	4,302,507	1,100,45
Kansas	2,588,814	882,984	2,769,849	782,676	2,811,448	947,369	2,159,859	806,027
Louisiana	([b])	([b])	([b])	([b])	([b])	([b])	([b])	([b])
California	899,028	374,828	886,564	558,889	937,514	519,667	1,086,163	555,359
West Virginia	145,157	70,481	150,492	76,463	155,625	62,955	183,379	78,805
Texas	442,571	255,652	409,315	260,286	382,164	272,568	385,200	299,537
Utah	242,678	169,833	246,935	147,318	249,850	185,869	272,420	171,268
Hawaii	....	....	7,796	5,292	11,450	9,570	8,463	11,850
Idaho	1,114	1,413	793	1,118	885	1,127	314	532
Porto Rico	....	....	166,790	26,810	([c])	([c])	([c])	([c])
Nevada	9,714	4,785	16,107	19,847	17,535	10,600	12,856	16,952
Oklahoma	([c])	([c])	([c])	([c])	2,564	881	500	431
Other States	[d] 847,357	84,172	[d] 887,231	92,140	[e] 968,229	120,774	[e] 1,217,305	133,172
Total	28,822,062	7,553,632	30,107,646	8,343,831	30,305,656	7,900,344	31,183,968	8,345,692

[a] Includes Louisiana.
[b] Included in New York.
[c] Included in "Other States."
[d] Includes New Mexico, Oklahoma, Pennsylvania, and Virginia.
[e] Includes New Mexico, Pennsylvania, Porto Rico, and Virginia.

In quantity of salt produced New York led among the States in 1911. Michigan ranked second and was followed by Ohio, Kansas, Louisiana, and California, this being the order among the States which held in 1910. The other States which produced salt were in order of their production as follows: Virginia, Texas, Utah, West Virginia, Pennsylvania, Nevada, New Mexico, Oklahoma, and Idaho. If Porto Rico were included in the list, it would come between West Virginia and Pennsylvania, and Hawaii would come between Nevada and New Mexico.

Based on the value of product, this order does not hold. Michigan ranks higher in value than New York and California than Louisiana. Several conditions affect the value of California salt—its manufacture in large part along the seacoast and the loss from winter floods, to compensate for which higher prices must be charged, the isolation of the larger centers of consumption on the Pacific coast from eastern competition, and the facts that the output of Louisiana is entirely rock salt and that the producers do not prepare the finer grades, which form a considerable part of the California production and which naturally have a higher value. The relative positions of the other States, based on value of output, are as follows: Texas, Utah, West Virginia, Virginia, Pennsylvania, Nevada, New Mexico, Idaho, and Oklahoma. The reason for Virginia's position in this list is that a lower value is placed on her output of salt because it is used in the form of brine by the Mathieson Alkali Works at Saltville, and hence is not placed on the market as salt. The value of the output at Porto Rico is not so great as that of Pennsylvania, hence the position of the island is between Pennsylvania and Nevada. Hawaii ranks between Nevada and New Mexico in both lists.

Production by States and grades.—The following table shows the grades of salt produced in the different States in 1910 and 1911. Brine and "Other grades" are combined in order to conceal the individual production of dry salt obtained from the brine:

Production of salt in 1910 and 1911, by States and grades, in barrels.

1910.

States.	Table and dairy.		Common fine.		Common coarse.		Packer's.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
California	257,957	$266,566					131,750	$64,979
Hawaii							3,571	3,000
Idaho	14	38	171	$279	214	$234		
Kansas	156,421	158,946	1,155,307	473,632	142,129	42,996		
Michigan	798,434	565,653	2,216,181	734,823	1,992,465	596,301	92,426	43,942
Nevada	714	1,500	5,714	1,600	178	200		
New York	1,258,086	605,878	1,322,014	383,940	231,971	77,880	49,914	15,225
Ohio	885,300	478,426	976,486	298,893	217,321	69,581	49,643	20,288
Oklahoma	1,071	113	179	250				
Texas	93,243	90,345	245,057	149,075	11,607	8,576		
Utah	57,307	77,769	17,729	17,093				
West Virginia	4,529	3,170	147,785	58,789				
Other States [a]	1,672	1,423	66,673	40,012	6,852	3,637		
Total	3,514,748	2,249,827	6,153,296	2,158,386	2,602,737	799,405	327,304	147,434

States.	Coarse solar.		Rock.		Other grades and brine.		Total.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
California	466,614	$146,193	78,571	$39,000	2,622	$2,929	937,514	$519,667
Hawaii	7,879	6,570					11,450	9,570
Idaho			350	386	136	190	885	1,127
Kansas			1,338,357	266,058	19,234	5,737	2,811,448	947,369
Louisiana			(b)	(b)			(b)	(b)
Michigan			247,582	79,226	4,104,934	211,317	9,452,022	2,231,262
Nevada	10,929	7,300					17,535	10,600
New Mexico							(c)	(c)
New York	439,778	129,295	[d]5,256,307	[c]1,214,639	3,084,450	158,882	[d]11,642,520	[d]2,585,739
Ohio	32.857	6,900			1,512,243	77,875	3,673,850	951,963
Oklahoma	1,314	518					2,564	881
Pennsylvania							(c)	(c)
Porto Rico							(c)	(c)
Texas	24,757	18,872			7,500	5,700	382,164	272,568
Utah	122,243	65,947	44,771	13,804	7,800	11,256	249,850	185,869
Virginia							(c)	(c)
West Virginia					3,311	996	155,625	62,955
Other States [a]	117,000	36,900			776,032	38,802	968,229	120,774
Total	1,223,371	418,495	6,965,938	1,613,113	9,518,262	513,684	30,305,656	7,900,344

[a] Includes New Mexico, Pennsylvania, Porto Rico, and Virginia.
[b] Included in New York.
[c] Included in Other States.
[d] Includes Louisiana.

Production of salt in 1910 and 1911, by States and grades, in barrels—Continued.

1911.

States.	Table and dairy.		Common fine.		Common coarse.		Packer's.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
California	321,379	$299,252	7,079	$1,982			123,313	$53,78
Hawaii								
Idaho	28	58	36	73	86	$137		
Kansas	151,057	133,902	1,096,129	417,271	117,107	46,843		
Louisiana								
Michigan	817,486	742,702	2,362,075	698,203	2,070,745	745,720	105,401	45,42
Nevada	1,836	6,173	36	70				
New Mexico								
New York	1,312,000	629,581	1,073,400	312,004	320,507	103,184	76,107	21,30
Ohio	993,663	499,689	1,231,357	344,506	440,322	132,322	104,036	42,34
Oklahoma								
Pennsylvania								
Porto Rico								
Texas	114,022	129,181	235,814	147,905	15,222	9,613		
Utah	56,207	83,542	21,986	12,708			71	9
Virginia								
West Virginia	4,129	2,900	174,679	74,505				
Other States	1,991	1,691	65,259	39,300	6,503	3,800		
Total	3,773,798	2,528,671	6,267,850	2,048,527	2,970,492	1,041,619	408,928	162,945

States.	Coarse solar.		Rock.		Other grades and brine.		Total.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
California	607,221	$185,684	23,350	$11,442	3,821	$3,219	1,086,163	$555,359
Hawaii	8,463	11,850					8,463	11,850
Idaho	93	144	71	120			314	532
Kansas			769,691	197,361	25,875	10,650	2,159,859	806,027
Louisiana							(a)	(a)
Michigan			553,664	177,172	4,410,703	223,937	10,320,074	2,633,155
Nevada	8,056	8,079	2,606	2,405	322	225	12,856	16,952
New Mexico							(b)	(b)
New York	435,414	141,510	4,839,592	1,164,487	3,177,908	166,076	[c] 11,234,928	[c]2,538,151
Ohio					1,533,129	81,591	4,302,507	1,100,453
Oklahoma	307	350			193	81	500	431
Pennsylvania							(b)	(b)
Porto Rico							(b)	(b)
Texas	16,571	11,238			3,571	1,600	385,200	299,537
Utah	148,243	47,314	36,242	14,244	9,671	13,370	272,420	171,268
Virginia							(b)	(b)
West Virginia					4,571	1,400	183,379	78,805
Other States	116,072	35,750			1,027,480	52,631	[d] 1,217,305	[d] 133,172
Total	1,340,440	441,919	6,225,216	1,567,231	10,197,244	554,780	31,183,968	8,345,692

[a] Included in New York.
[b] Included in "Other States."
[c] Includes Louisiana.
[d] Includes New Mexico, Pennsylvania, Porto Rico, and Virginia.

DOMESTIC CONSUMPTION.

In the following table is given the consumption of salt in the United States during 1911. In addition to the domestic production of 31,183,968 barrels, there were imported 1,014,926 barrels. These imports were partly offset by exports which amounted to 349,092 barrels, leaving an excess of imports over exports of 665,834 barrels. This added to the domestic production brings the total salt consumed up to 31,849,802 barrels, an increase of 914,935 barrels as compared with 1910. The imports amounted to 3.2 per cent of the total salt consumed, which is the same ratio as for 1910. In 1909 the ratio was 3.4 per cent, and in 1908 it was 3.8 per cent. Thus the country in 1911 produced 96.8 per cent of the salt which it consumed. The United States is amply able to supply all the domestic demands, as the capacity of the active mines and plants is largely in excess of the present output. Moreover, there are many plants now idle that could readily resume operations should conditions warrant it.

With the increase of production of salt in Michigan and the Middle West during recent years, the producers in New York had to find a market for the most part locally or in the New England States where they receive protection through the reduced freight rates due to shorter haulage. Foreign salt from the West Indies and the Mediterranean countries is, however, a strong competitor with New York salt for the trade of the seaboard towns of New England. The imports will probably increase in the future, as the Payne-Aldrich tariff bill reduced the duty by 20 cents a short ton on all grades of salt. It is this salt which can compete with the New York product and which makes up the bulk of the imports given in the following table:

Supply of salt for domestic consumption, 1880–1911, in barrels.

Source.	1880	1890	1900	1910	1911
Domestic production	5,961,060	8,876,991	20,869,342	30,305,656	31,183,968
Imports	3,427,639	1,838,024	1,427,921	979,305	1,014,926
Total	9,388,699	10,715,015	22,297,263	31,284,961	32,198,894
Exports	4,436	17,597	53,650	350,094	349,092
Domestic consumption	9,384,263	10,697,418	22,243,613	30,934,867	31,849,802
Comparison with preceding year		+877,610	+1,274,634	+46,032	+914,935
Percentage of imports to total consumption	36.5	17.2	6.4	3.2	3.2

IMPORTS.

There were imported into the United States in 1911, 284,179,200 pounds, or 1,014,926 barrels, of salt, valued at $375,030; the corresponding imports for 1910 were 274,205,582 pounds, or 979,305 barrels, valued at $370,922. The increases took place in the salt imported in packages and for use in curing fish. The imports of bulk salt, not further designated, fell off.

According to figures obtained from the Bureau of Statistics of the Department of Commerce and Labor, the quantity and value of the salt imported and entered for consumption in the United States in the last six years is as follows:

Salt imported and entered for consumption in the United States, 1906–1911, in pounds.

Year.	In bags, barrels, and other packages.		In bulk.		For the purpose of curing fish.		Total quantity.	Total value.
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.		
1906	74,228,878	$257,592	159,674,675	$149,944	115,359,107	$101,326	349,262,660	$508,862
1907	74,762,435	242,377	115,826,979	108,166	107,008,980	100,739	297,598,394	451,282
1908	66,409,270	219,272	153,031,808	120,979	99,844,560	104,439	319,285,638	444,690
1909	65,581,839	220,503	135,735,445	132,884	97,722,473	84,440	299,039,757	437,827
1910	53,143,200	178,000	118,796,400	104,822	102,265,982	88,100	274,205,582	370,922
1911	61,648,200	181,405	108,055,700	95,801	114,475,300	97,824	284,179,200	375,030

EXPORTS.

The exports of salt in 1911 were 97,745,833 pounds, or 349,092 barrels, valued at $335,285. As compared with the exports in 1910, this was a slight decrease of 1,002 barrels in quantity, but the value of the exports increased $14,359. The value of salt exported in 1911 was the greatest thus far recorded by the Survey. The export of salt of domestic production from the United States from 1906 to 1911 is shown as follows:

Salt of domestic production exported from the United States, 1906–1911.

1906....pounds..	67,976,581	$274,627	1909....pounds..	80,306,820	$269,273
1907.......do....	61,603,422	232,895	1910.......do....	98,026,369	320,926
1908......do....	53,253,739	202,338	1911.......do....	97,745,833	335,285

SOURCE OF SALT IN THE UNITED STATES.

MINERALOGY.

Common or rock salt is known mineralogically as halite. Chemically it is the chloride of sodium and contains 39.4 per cent chlorine, which in its natural condition is a gas, and 60.6 per cent sodium, which in its natural condition is a metal.

The mineral is rather brittle and has a conchoidal fracture. Its hardness is 2.5. Its specific gravity varies from 2.1 to 2.6, that of the pure crystals being 2.135. Its index of refraction is 1.5442. It is highly diathermous. It seldom occurs in pure form, but is mixed with a variety of other saline minerals, chief among which are gypsum, anhydrite, carnallite, kieserite, and polyhalite, or it is associated with shale and sandstone.

Halite is isometric in crystalline form and usually occurs as cubes, which are commonly distorted and in cavernous shapes and are referred to as hopper-shaped crystals. It also occurs in massive form, with granular to compact structure. Masses with perfect cubical cleavage are common, as well as the fibrous variety, which is said to be pseudomorphous after gypsum. It has a vitreous luster and when pure is transparent and colorless. Its different shades of color are due to impurities, which impart to it yellow, red, brown, blue, and purple hues, and which, moreover, are responsible for its varying degrees of translucency. It is readily soluble in water. Its characteristic saline test is known to all.

OCCURRENCE.

Salt is widely distributed and frequently occurs in beds of sufficient size to constitute true rock masses. It is also found in solution in salt springs, in the waters of the ocean, and in inland salt lakes or seas, as, for example, Great Salt Lake, Utah, and the Dead Sea. The deposits of rock salt which are interstratified with rocks of various geologic ages have been formed originally for the most part by the gradual evaporation of bodies of sea water which have been cut off from the main ocean. The salt water of inland salt lakes or seas, as in the case of Great Salt Lake and the Dead Sea, has been concentrated by evaporation owing to the lack of an outlet. The mineral matter of inclosed bodies of salt water is usually regarded as crystallizing out in inverse ratio to its solubility, the less soluble minerals, like gypsum, forming before the more soluble ones, like salt. The order of natural deposition taken as a whole is in harmony with this principle, but the composition of the solution plays an important part in the order of deposition.[1]

Rock salt is of such universal occurrence that a list of the localities where it is found would include almost every civilized country. In the United States extensive deposits are known in central and western New York, Ohio, Michigan, Virginia, Kansas, Louisiana, Nevada, Utah, Arizona, California, Idaho, Oklahoma, Wyoming, and probably in other States. Salt springs and wells abound in the neighborhood of the salt deposits, and these as well as the waters of salt lakes and sea water are used as sources of the commercial product.

USES.

Salt is used to form a glaze on pottery, in enameling and pipe works, in many chemical and metallurgical industries, for salting cattle, in refrigerating, curing hides, making pickles, for preserving butter, clearing oleomargarine, as well as for the more familiar culinary and preservative purposes.

THE SALT INDUSTRY BY STATES.

In 1911 salt was produced in the United States in 15 States, as follows: California, Idaho, Kansas, Louisiana, Michigan, Nevada, New Mexico, New York, Ohio, Oklahoma, Pennsylvania, Texas, Utah, Virginia, and West Virginia. A production was reported also from Hawaii and Porto Rico. The salt-producing localities in the United States were indicated on the map accompanying this report for 1910, to which the reader is referred.

CALIFORNIA.

In quantity of salt produced California ranked sixth among the States in 1911. In value of output it ranked fifth, maintaining the same relative rank in the salt industry that it has had since 1907. The output in 1911 was 1,086,163 barrels, or 152,063 short tons, valued at $555,359, an average of 51 cents per barrel and of $3.65 per ton. It is of interest to compare these figures with the averages for the whole United States in 1911, which were respectively 26.763 cents per barrel and $1.91 per short ton. The reasons for the higher prices in California have already been outlined.

The salt produced in California is chiefly coarse solar salt, but a large quantity of the finer grades is made by recrystallizing the coarser salt. The value or price of the coarse solar product is considerably below the averages for California salt as given above, while the value of the dairy and other fine grades are above those figures. Practically all the salt produced in California in 1911 came from Alameda, Kern, Los Angeles, Modoc, San Bernardino, San Diego, and San Mateo counties. By far the greater part of the salt produced along the seacoast is, before refining, the coarse solar grade. Some rock salt was reported from San Bernardino County.

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[1] Van't Hoff, J. H., Physical chemistry in the service of the sciences, University of Chicago Press, 1903, pp. 100-119.

IDAHO.

The production of salt in Idaho in 1911 amounted to 314 barrels, or 44 tons, valued at $532. The salt was produced in Bannock and Bear Lake counties, but the headquarters of most of the operators are across the State line in Auburn, or Afton, Wyo. A complete account of the salt resources along the Idaho and Wyoming border in this region by C. L. Breger has been published in a Survey bulletin referred to in the bibliography at the end of this report.

KANSAS.

Kansas ranked fourth among the States in 1911, both in quantity and in value of salt produced. The output of salt in this State for the year was 2,159,859 barrels, or 302,380 tons, valued at $806,027, which was considerably less than for the year 1910, when the production of the State amounted to 2,811,448 barrels, or 393,603 short tons, valued at $947,369. The salt was produced in 1911 as usual in Ellsworth and Kanopolis, Ellsworth County; Lyons and Sterling, Rice County; Hutchinson, Reno County; and Anthony, Harper County. A new company, the Lyons Salt Co., began operations at Lyons in November, 1911.

The salt industry in Kansas depends upon the rock salt found in Permian strata and includes the mining of this salt and the evaporation of artificial brines from wells drilled to it. An immense body of rock salt underlies the surface in central Kansas. Its exact horizontal boundary is not known. It probably does not reach to the northern border of the State, but it is known to extend southward into Oklahoma. In thickness it varies up to 400 feet, and it consists of alternating layers of salt, shale, limestone, anhydrite, and gypsum, the individual layers of salt attaining a thickness of 20 feet or more.

By far the larger part of Kansas salt is obtained by evaporation, but a considerable quantity is obtained by mining. The processes of obtaining salt by mining and evaporation have been described by Young[1] and Ainsworth.[2] In his first paper Young discusses the evaporated-salt industry, which has its center at Hutchinson. He describes the manner of obtaining the brines from the wells, the various processes—direct heating, grainer, and vacuum pan—of converting the brine into salt, the methods of handling the salt, and the productive capacity of the district. In the second paper he gives complete descriptions of the occurrence, the history of the sinking of the shafts, and the operations connected with the mining of rock salt in central Kansas.

In 1887 and 1888 the important salt beds of Kansas were found while wells were being drilled for oil and gas. They have been developed in an area located in the south-central part of the State, in Rice, Reno, Kingman, and parts of the adjoining counties, including Ellsworth, Saline, McPherson, Harvey, Sedgwick, Sumner, Harper, Barber, Pratt, Stafford, Barton, and Russell. In the early history of the industries numerous shafts were sunk to the salt deposits, but from lack of experience and funds to carry on the work many of them proved failures. Only three important operations may be listed among the plants mining rock salt at the present time.

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[1] Young, C. M., Notes on the evaporated salt industry of Kansas: Eng. and Min. Jour., Sept. 18, 1909, pp. 558–561; also Rock salt mining operations in central Kansas: Min. World, June 17, 1911, pp. 1223–1225.

[2] Ainsworth, Samuel, The rock salt mining industry in Kansas: Eng. and Min. Jour., Sept. 4, 1909, pp. 454–456.

The Kansas salt field was visited by the writer in the fall of 1911 and the mines were inspected, samples were collected, and the methods of mining and evaporating the salt were studied. The observations made during that visit are to be embodied in a report now in preparation on the salt industry in the United States, in which special attention will be paid to the subject of potash salts.

LOUISIANA.[1]

The salt mined in Louisiana in 1911 came from Weeks and Avery islands, located in Iberia Parish. Of the producing localities, Weeks Island is located on the east shore of Weeks Bay, an eastern lobe of Vermilion Bay. It is sometimes called Grande Côte, on account of its size, though it is scarcely 2 miles in diameter. Prospecting for salt began here in 1897, and in 1898 the Myles Salt Co., which now works the deposits, was organized. After considerable prospecting with the drill, the location of a shaft was determined on in 1898, and in March, 1902, the 600-foot level was reached and tunnels were driven east and west. The extreme depth of the shaft is now 645 feet. North of the shaft the salt is impure; to the west there is danger of the tunnel running out of the salt and into the overlying sand, and hence of ruining the mine. To the east the salt is excellent, and there seems to be no danger ahead.

Mining is carried on by first undercutting or blasting out triangular masses of salt on the level with the floor of the mine, then blasting down layer after layer, already undermined. The drills are worked by compressed air furnished by the compressors in the power house at the surface. The salt is conveyed to the shaft in small dump cars drawn by mules over narrow-gage steel tracks. At the shaft the salt is passed through the crusher and falls into a huge bin below. From this it is drawn off into a 5-ton self-dumping cage that is capable of making a round trip, that is, from the bottom of the shaft to the top of the mill at the surface and back to the bottom of the shaft, in four minutes. The capacity of the mine is about 75 tons per hour or 750 tons per 10-hour day.

The mine is lighted by electricity. Ventilation is usually fair but less satisfactory than it would be if there were provided an entrance and an exit shaft for the air in distant parts of the mine. Fire damp or inflammable gases are practically unknown in this mine. In the engine room a pair of 20 by 30 foot engines, geared back 3½ to 1, turn an 8-foot drum that winds up the cable lifting the cage.

Besides these engines for hoisting there are two air compressors for working the drills in the mine and one small engine for working the ventilating fans. The power used to run the crusher at the bottom of the shaft, as well as the screens and the general millwork above, is transmitted by insulated wire cables from a dynamo in the engine room. The various boilers use fuel oil.

Salt of various grades is produced at the mill by passing the crushed salt after it is dumped from the cage on the uppermost floor of the mill through screens of different mesh. Shipment is made v the Salt Mine branch of the Southern Pacific Railroad, either in bu or in sacks. Some of the salt is shipped in huge lumps and is use by cattlemen for salting their stock. In a moderately dry clima these lumps last a year or more, or until consumed by the cattl The Myles Salt Co. has furnished the following data regarding th uses to which these various grades of salt are put:

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[1] Harris, G. D., Rock salt in the State of Louisiana: Bull. Louisiana Geol. Survey No. 7, 1908, p. 5.

> The crushed salt, grades Nos. 1, 2, and 3, is used in refrigerating, curing hides, curi fish, making salt pickles, glazing in enameling and pipe works, and No. 3 is especial adapted for capping all sorts of meats put up in pickle in barrels. The C (coarse) ar F (fine) salt is used for dry salting meats, clearing oleomargarine, and in all sorts chemical works. The A grade is a special one made to suit the customer who regar No. 1 as too large and the C as too small for his purposes, such as making ice crea and pickles. The D grade is also a special one, consisting of powdered salt whi results from the grinding of any of the crushed grades in the mill and which is use for any purpose where rapid solution of the salt is desired.

Salt is also mined on Avery Island, located in Iberia Parish, 10 mil southwest of New Iberia. Rock salt was discovered here in 186 and an 8 by 8 foot shaft, 83 feet deep, was sunk in 1867, whose dept was afterwards increased to 90 feet. Mining was carried on b driving long, narrow chambers in an east-west direction and finall in a north-south direction as well. The mine was afterwards floode In 1885 the shaft was deepened to 168 feet. It was subsequentl flooded a second time. A new shaft was begun in 1899.

The details connected with the new mine are as follows: The sha is 21 by 10 feet, is 518 feet deep, and is divided into two hoists and a air shaft. The galleries, about a mile of which were driven in 190 are 30 feet wide, and run at right angles with one another, havin square pillars 30 feet on a side as supports.

Here, as well as at Weeks Island, the salt is conveyed from th place of mining to the foot of the shaft by means of small cars draw on a narrow-gage steel track by horses or mules. Here, however, th cars are drawn upon the platform of the cage and hoisted and dumpe by hand at the top floor of the mill. The heavy crushing is therefor done in the mill instead of at the foot of the shaft, as at Weeks Island The various grades of salt produced are used for practically the sam purposes as similar grades from Weeks Island. The purity of th salt is such that no purification processes are required. The salt i simply crushed, screened, ground, and winnowed to drive off the fin salt-dust particles. The elimination of the finest, dustlike particle is necessary owing to their tendency to deliquesce and cement togethe the larger salt grains.

MICHIGAN.

Michigan ranked second among the States in quantity but first i value of salt produced in 1911. The output of the State wa 10,320,074 barrels, or 1,444,810 tons, valued at $2,633,155, includin the salt contained in the brine, which is extensively worked up int soda and other sodium chemicals. The production in 1910 wa 9,452,022 barrels, or 1,323,823 tons, valued at $2,231,262.

The salt that is worked in Michigan occurs as rock salt and a natural brine. Rock salt is mined as such only by the Detroit Sal Co., at Detroit. The other companies utilizing rock salt do so b means of fresh water brought into contact with it, which, afte becoming partly or wholly saturated with the salt, is raised to the surface and evaporated. All of the salt companies operating in Michigan outside of the Saginaw Valley obtain brine in this way.

The rock salt which is the source of the artificial brine occurs in the Monroe formation, consisting of Silurian rocks, which have sometimes been called "Salina," but which are not known to be the same as the Salina formation of New York. The salt in the vicinity of Detroit and along St. Clair River belongs to this horizon, and presumably this is also true of the rock salt furnishing the brines near Manistee and Ludington in the western part of the Lower Peninsula.

In the Saginaw Valley salt is made on a large scale at Saginaw and to a less extent near Bay City, St. Charles, and Mount Pleasant. The raw material used is natural brine occurring in the sandstones of the Marshall formation (lower Carboniferous), whose base occurs from 750 to 1,000 feet below the surface along Saginaw River. These sandstones are higher in the geological column than the rocks carrying rock salt worked near Detroit and along St. Clair River. The natural brines from the sandstones of the Marshall formation yield bromine and calcium chloride which are produced on an extensive scale in the Saginaw Valley.

NEVADA AND NEW MEXICO.

In 1911 the salt produced in Nevada came from Churchill, Esmeralda, and Washoe counties. The quantity produced was 12,856 barrels, or 1,800 tons, valued at $16,952—a decrease as compared with 1910 when the quantity produced was 17,535 barrels, or 2,455 tons. In New Mexico a small production of salt in 1911 was reported from Torrance County.

NEW YORK.

New York ranked first among the States in 1911 in quantity of salt produced, but second in value of the product. The figures for this State can not be given as those of Louisiana have been combined with them for concealment of the latter.

Salt in New York occurs as brine and also as rock salt. Brine is found at Syracuse in glacial drift and in some places wells more than 300 feet deep have been sunk to the salt water. The brine from the shallow wells becomes weaker after continuous pumping, but the deeper wells apparently are not thus affected. From the Syracuse brine the salt is manufactured either by artificial or by solar evaporation. The solar salt is made almost entirely in Onondaga County, and Syracuse has long been the center of the industry which dates back more than 100 years. In 1797 the Syracuse district was made a State Indian reservation and most of the salt wells are now located on the reservation. The brine, which contains 17 to 20 per cent of sodium chloride, is furnished to operators at a fixed charge.

The rock salt beds of New York occur almost exclusively in the Salina formation, or, as it has been sometimes called, the "Onondaga salt group," of the Silurian system. According to Vanuxem,[1] this important formation contains all the gypsum masses of western New

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[1] Report on the geology of the third district of New York, 1842.

York and furnishes all the salines of Onondaga and Cayuga counti
The Salina formation was described by James Hall[1] as follows:

> Succeeding the Niagara group is an immense development of shales and marls wi
> shaly limestones, including veins and beds of gypsum. The general color is as
> approaching drab, with some portions of dark bluish green. The lower part is of de
> red, with spots of green. Succeeding this, where protected from atmospheric
> fluences, the rock is blue like ordinary blue clays, with bands of red or brown. T
> portion and that succeeding it are often green and spotted and contain seams of fibro
> gypsum and small masses of reddish selenite and compact gypsum. From this
> becomes gradually more gray, with a thin stratum of clayey limestone, which is som
> times dark, though generally of the same color as the surrounding mass. The form
> tion terminates upward with a gray or drab limestone called by Vanuxem the "m
> nesian deposit." The red shale forming the lower division of the group is well
> veloped, but in the third district has not been found west of the Genesee River.
> appears in the eastern part of Wayne County, as indicated by the deep-red color
> the soil which overlies it.

In their studies of the surface, Hall and Vanuxem found no ro
salt because this mineral, being soluble, can not remain at the su
face; but from various wells put down since their time sections of t
Salina formation have been obtained which show the position an
relation of the salt beds.

Throughout the Oatka-Genesee district, which was visited by t
writer in 1911, the salt is usually found at levels varying from 550
750 feet below the surface of the Onondaga limestone. Exceptio
to this are few in number. The upper surface of the Onondaga h
been taken as the datum plane to determine the relative position
the salt beds, because it is invariably recognized by the driller. I
persistent character and the abundance of chert scattered through
contrast strongly with the overlying soft shales and thin limestone

The dip of the strata in western New York is approximately sout
east at the rate of about 60 feet to the mile, and the section betwee
Le Roy, in eastern Genesee County, and Gainesville Creek shows tha
the beds do not slope uniformly to the south but undulate in tha
direction. Extraneous evidence seems to point to the fact that man
of the wells and shafts of New York have penetrated only little mor
than halfway through the salt masses.

The salt produced in 1911 in New York came from near Syracus
Onondaga County; Le Roy, Genesee County; Cuylerville, Piffar
and Retsof, Livingston County; Watkins, Schuyler County; Ithac
and Myers, Tompkins County; and Rock Glen, Salt Vale, and Silve
Springs, Wyoming County.

OHIO.

Ohio ranked third, as usual, among the States in both quantity an
value of the salt produced in 1911, being exceeded by New York an
Michigan. The production of the State was 4,302,507 barrels, o
602,351 tons, valued at $1,100,453, as compared with 3,673,850 bar-
rels, or 514,339 tons, valued at $951,963, in 1910.

The salt produced in Ohio comes from two distinct districts, th
northeastern district, comprising Cuyahoga, Medina, Summit, an
Wayne counties, and the southeastern district, comprising Meigs an
Morgan counties. In southeastern Ohio Meigs County is by far th
larger producer, and Pomeroy is the center of the industry. Th

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[1] Geology of the fourth district of New York, 1843.

salt horizon of the northeastern part of the State is in the Monroe formation of the Silurian. The surface rocks in the Ohio Valley near Pomeroy, Ohio, and Mason, W. Va., lie near the top of the Conemaugh formation, formerly known as the "Lower Barren Coal Measures." The depths of wells in this region have undergone great variation. At first wells were very shallow, but later they were extended to greater depths as the supply of brine near the surface became exhausted. When the supply from these deeper wells became inadequate they were sunk to still greater depths. At present salt works both in Ohio and in West Virginia are pumping brine from depths of 1,100 to 1,350 feet. The brine-bearing strata dip toward Pomeroy from the northwest, and as the brine has been removed from the wells the supply has been renewed from the rocks lying at higher levels in that direction. The brine was doubtless once a part of the ocean, and as the sand or gravel now constituting the salt-bearing rocks was deposited on the ocean floor, sea water filled the spaces between the grains and pebbles and has since remained in that position. It must be borne in mind that the Pomeroy brines were formed very near the shore, probably within a landlocked sea, and hence might vary considerably from those formed in the open ocean. This explains the presence of the relatively large quantities of bromides and iodides, for these substances are contained in certain marine plants. It is possible that the conditions were favorable for these plants in the early sea in the vicinity of Pomeroy. The wells along Ohio River procure their brine chiefly from a horizon approximately near the base of the Salt sand of the Carboniferous.

OKLAHOMA.

The small production of salt from Oklahoma in 1911 came from Harmon County. No production was reported from Blaine County.

PENNSYLVANIA.

Pennsylvania salt, as usual, was reported from Pittsburgh. The brine from which the salt is made comes from a depth of approximately 1,400 feet and from the sand known in the record as the Salt sand, which is considered to be of Pottsville age.

TEXAS.

The production of salt in Texas in 1911 amounted to 385,200 barrels or 53,928 tons, valued at $299,537. The production during 1910 was 382,164 barrels or 53,503 tons, valued at $272,568. The increase in value was relatively very much greater than the increase in quantity of salt produced. Salt in Texas occurs along the Gulf coast and in many salines and lagoons in the interior. The counties which produced salt in 1911 were Anderson and Van Zandt in the eastern part of the State and Mitchell in the western part. The plant of the Colorado Salt Co., located at Colorado, Mitchell County, was destroyed by fire November 11, 1911. It is expected that it will be rebuilt.

UTAH.

The production of salt in Utah in 1911 was 272,420 barrels o 38,139 tons, valued at $171,268, as compared with 249,850 barrels o 34,979 tons, valued at $185,869, in 1910. Though the production i 1911 was greater than that of the preceding year, the value of th product declined considerably. Utah salt is produced in Salt Lak and Sevier counties. In Salt Lake County the salt is obtained b solar evaporation from the waters of Great Salt Lake, and Salt Lak City is the center of the industry. An account of the industry a carried on at Great Salt Lake is given by Percy E. Barbour,[1] and th notes given below are abstracted from Barbour's article.

Great Salt Lake has a length of approximately 75 miles and a widt of about 30 miles. Its area therefore is approximately 2,250 squar miles. It is comparatively shallow, its average depth probably no exceeding 15 feet. Its level varies from season to season, as well a from year to year, and the density of its water changes likewise With the exception of the Dead Sea, the water of Great Salt Lake i the densest natural water in the world. It contains total solid varying from 15 to 22 per cent by weight. The water therefore i about 5 to 6 times as salty as average ocean water, the salinity o which varies from 3.3 to 3.7. With this large saline content and th climatic conditions, all the factors are favorable for rapid and profitable solar evaporation. It is hardly necessary to mention that th saline matter is brought into the lake in solution in the stream which drain into it from the surrounding country. The lake has n outlet and the evaporation is rapid, which accounts for the presen accumulation of the salts in solution.

Two companies are now engaged in the salt industry on the shore of Great Salt Lake, of which the Inland Crystal Salt Co. is the larger.

The pumping season begins as early as the weather will permit generally some time during May. Pumping is done with centrifuga pumps into a wooden flume which carries the brine to the salt pond 2 miles away. Seven thousand to 8,000 gallons of water a minut are pumped during 10 hours a day, and it requires about 10 days t fill the settling pond to which the brine goes first. In the settlin ponds all foreign matter like cinders, sand, etc., settles out and th brine overflows to the stock pond, having reached a salinity of 22 pe cent during its passage through the settling pond. It is in the stock ponds from 3 to 10 days, or until it reaches a strength of 26 per cent o salt, when it is drawn off to the harvest ponds, where the salt deposits These last ponds are prepared for the salt crop by the preliminary deposit of a salt bottom or floor on which the subsequent salt is deposited, thus insuring a clean harvest. The annual deposit ranges in thickness from 2 to 6 inches, depending of course upon the weather conditions. The 1910 crop was 5 inches thick.

The harvesting season begins in October. The mother liquor amounting to nearly 10 per cent of the inflow, is drained off and returned to the lake, care being taken to prevent the soda from depositing; the salt is allowed to deposit and dry; and harvesting then begins. The hard, level, solid mass is broken up by plows, and is then stacked by means of scrapers and wheelbarrows in large piles of uniform size along the railroad track. The loss from these piles due to solution by rain during autumn and spring amounts to 10 per cent.

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[1] Eng. and Min. Jour. July 8, 1911, pp. 74–75.

As already stated, a railroad spur runs to the stock piles, from which the crude salt is shipped in bulk to the market or to the company's mill on the lake shore about 1½ miles away. The mill is new, having been built to replace the old one which burned in November, 1908. In the mill the salt is dried, crushed, and bolted into various grades of table and dairy salt. Large quantities of the salt are sold to chlorination mills and to the cattle trade for salting cattle.

VIRGINIA.

Deposits of salt and gypsum are known to occur in Washington and Smythe counties, Va., in a belt of country 20 miles long running northeast from the village of Plasterco. The region is made accessible by the Saltville branch of the Norfolk & Western Railway which joins the main line at Glade Spring. The rocks in which the deposits occur are, according to G. W. Stose,[1] of Mississippian (lower Carboniferous) age, and are thought to represent segregations or concentrations of salt and gypsum formerly disseminated in the associated rocks.

Two gypsum and one salt or alkali works are in operation in this area. The salt or soda industry is now conducted by the Matheison Alkali Works, with offices at Saltville. Since 1895, when this company came into control of the property, the brine has been converted into soda products other than salt, chiefly bicarbonate of soda or baking soda, soda ash used in the manufacture of glass, pottery, etc., and sal soda. Caustic soda is also made and put up for the trade in hermetically sealed cans.

Over 50 wells have been drilled in the vicinity of Saltville, about 25 of which are at present in operation. They range in depth from a few hundred feet to 2,280 feet, the average being about 1,000 feet. The shallower wells are dry wells and have to be flushed with water through the outer casing. The deeper wells are wet, and the brine flows in as fast as it is pumped out. In the wet wells the rocks become honeycombed and cave in, in some wells bending the pipe so as to cripple or entirely disable the well. The brine is raised by ordinary deep pumps each operated by a walking beam driven by an electric motor housed in a small shack at the well. After being first piped to an open reservoir in the town, the brine is then piped to the company's plant on North Fork of Holston River, about a mile distant, where it is converted into baking soda and other sodium products by the ammonia or Solvay process.

WEST VIRGINIA.

The output of salt in West Virginia in 1911 amounted to 183,379 barrels, or 25,673 tons, valued at $78,805, a considerable increase as compared with 1910, when the production amounted to 155,625 barrels, or 21,787 tons, valued at $62,955. Salt in West Virginia is obtained from natural brines carrying appreciable quantities of bromine, which, together with calcium chloride, is extracted from them. The geology of the brine-bearing beds at Mason is similar to that at Pomeroy, Ohio, on the opposite side of Ohio River, in Meigs County. The geology of these brine-bearing beds has been worked out by J. A. Bownocker and published in Bulletin 8 of the Ohio Geological Survey; it has been repeated in this report in previous years, and has been outlined under Ohio in the present chapter. Natural brines also occur near Malden, W. Va., which is located on Kanawha River, a few miles above Charleston, the State capital. The record of a gas well on Cool Spring Branch of Burning Springs Hollow, about 3 miles from Malden, throws some light on the geology of the beds from which the brine is obtained. The record of the well, which is known as the Edwards well No. 1, has been published in a report by I. C. White.[1] According to White, the sandstone known to the oil men as the salt sand furnishes the brine in the Kanawha Valley. This sandstone belongs to the Pottsville formation and lies very near the base of the coal measures.

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[1] Stose, G. W., Geology of the salt and gypsum deposits of southwestern Virginia: Bull. U. S. Geol. Survey No. 530, 1912.

HAWAII.[2]

The production of salt in Hawaii in 1911 amounted to 8,463 barrels, or 1,185 tons, valued at $11,850, a decrease in quantity and an increase in value as compared with the production of 1910, which amounted to 11,450 barrels, or 1,603 tons, valued at $9,570.

PORTO RICO.

Both the quantity and the value of the salt produced in Porto Rico in 1911 were slightly greater than in 1910. Details are suppressed in order to conceal individual output.

BROMINE.

PRODUCTION.

The following table gives the production and value of the bromine produced in the United States since 1880:

Production and value of bromine, 1880–1911.

1880......pounds..	404,690	....	1897......pounds..	487,149	$129,094
1883........do....	301,000	....	1898........do....	486,979	126,614
1884........do....	281,100	$67,464	1899........do....	433,004	108,251
1885........do....	310,000	89,900	1900........do....	521,444	140,790
1886........do....	428,334	141,350	1901........do....	552,043	154,572
1887........do....	199,087	61,717	1902........do....	513,893	128,472
1888........do....	307,386	95.290	1903........do....	598,500	167,580
1889........do....	418,891	125,667	1904........do....	897,100	269,130
1890........do....	387,847	104,719	1905........do....	1,192,758	178,914
1891........do....	343,000	54,880	1906........do....	1,283,250	165,204
1892........do....	379,480	64,502	1907........do....	1,379,496	195,281
1893........do....	348,399	104,520	1908........do....	760,023	73,783
1894........do....	379,444	102,450	1909........do....	569,725	57,600
1895........do....	517,421	134,343	1910........do....	245,437	31,684
1896........do....	546,580	144,501	1911........do....	651,541	110,902

The bromine industry is centered in Michigan, Ohio, Pennsylvania, and West Virginia. Accounts of the bromine industry in these States have appeared in this report during previous years, and the reader is referred to these earlier chapters for detailed information.

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[1] West Virginia Geol. Survey, vol. 1, p. 272.

[2] Acknowledgment is due to Mr. H. P. Wood, secretary of the Hawaii Promotion Committee, Honolulu, for courtesies extended in the collection of the statistics for Hawaii.

CALCIUM CHLORIDE.

In connection with the salt and bromine industry in Michigan, Ohio, Pennsylvania, and West Virginia, there is produced a considerable quantity of calcium chloride. The production of this substance in 1911 amounted to 14,606 short tons, valued at $91,215, as compared with 10,971 short tons, valued at $74,713, in 1910.

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SULPHUR, PYRITE, AND SULPHURIC ACID.

By W. C. PHALEN.

SULPHUR.

PRODUCTION.

In 1911 sulphur was produced in Louisiana, Utah, and Wyoming. The production of the individual States can not be given without divulging confidential information. Nevada, which has hitherto produced on a small scale, reported no production of sulphur during the year. The admission of Japanese sulphur free of duty undoubtedly has affected the sulphur market in certain of the Western States. The production of Louisiana still continues to be the factor in the domestic industry, but in both Utah and Wyoming the output of sulphur was greater than during 1910.

In the present report a detailed description is given of the sulphur industry at Sulphur, Calcasieu Parish, La. A detailed account of the sulphur deposits of Sunlight Basin, Wyo., is also included, though this field has not yet become an actual producer. Wyoming sulphur in 1911 came from the Thermopolis district, which was described in this report for the year 1909. Utah sulphur in 1911 came from the Black Rock district, also described in previous reports of the Survey. The deposits in San Rafael Canyon, Utah, a brief outline of which is given in the following pages, have never been worked and it is doubtful if they can be worked in the present state of the industry.

The sulphur deposits in Mineral County, Colo., and near Soda Springs, Idaho, described in the following pages, have not been worked to any extent commercially, if at all. It has been thought worth while, however, to review them as it is one of the objects of this chapter to keep in touch with all the important literature relating to sulphur deposits, whether of present or prospective importance.

The production of sulphur in the United States in 1911 amounted to 265,664 long tons, valued at $4,787,049, as compared with 255,534 long tons, valued at $4,605,112, in 1910, an increase in quantity in 1911 of 10,130 long tons and in value of $181,937. In determining the value of most of the sulphur produced in 1911, the current market prices in New York were taken from which the value at the mine was then computed. It is estimated that the production for the year 1911 is very close to the present rate of consumption.

Prices remained fairly constant throughout the year at approximately $22 per long ton at New York for prime Louisiana sulphur and at $22.50 at Boston, Philadelphia, and Baltimore. Quotations on roll sulphur were from $1.85 to $2.15 per 100 pounds; for flour sulphur the range was from $2 to $2.40 per 100 pounds; and for sublimed sulphur it was from $2.20 to $2.60 per 100 pounds. Sicilian sulphur was held at the same figure.

The production of the country since 1880 is shown in the following table:

Production of sulphur in the United States, 1880–1911.

Year.	Quantity.	Value.	Year.	Quantity.	Value.
	Long tons.			*Long tons.*	
1880	536	$21,000	1896	4,696	$87,200
1881	536	21,000	1897	2,031	45,590
1882	536	21,000	1898	1,071	32,960
1883	893	27,000	1899	4,313	107,500
1884	446	12,000	1900	3,147	88,100
1885	638	17,875	1901	[a] 241,691	1,257,879
1886	2,232	75,000	1902	[a] 207,874	947,089
1887	2,679	100,000	1903	[a] 233,127	1,109,818
1888			1904	127,292	2,663,760
1889	402	7,850	1905	181,677	3,706,560
1890			1906	294,153	5,096,678
1891	1,071	39,600	1907	293,106	5,142,850
1892	2,400	80,640	1908	369,444	6,668,215
1893	1,071	42,000	1909	239,312	4,432,066
1894	446	20,000	1910	255,534	4,605,112
1895	1 607	42,000	1911	265,664	4,787,049

[a] Includes the production of pyrite.

IMPORTS.

In 1911 there were imported for consumption into the United States 29,144 long tons of sulphur, including crude, refined, flowers of sulphur, and other kinds. This sulphur was valued at $552,836. This importation is slightly less than that for 1910, which amounted to 30,833 long tons, valued at $558,611. The great bulk of the sulphur imported comes from Japan and is entered at Pacific coast ports as will be seen from the second table given below. Japanese sulphur is consumed chiefly on or near the Pacific coast.

Regarding the importation of sulphur, the Treasury Department has revoked the decision of July 25, 1911, that sulphur mined in Hokkaido and exported from Hakodate, Japan, should be assessed with duty as sulphur refined at the rate of $4 per ton under paragraph 81 of the tariff act. The department is satisfied that this sulphur, which is roasted in furnaces after being taken from the mines and contains from 90 to 97 per cent of pure sulphur, is not refined within the meaning of said paragraph 81. The sulphur referred to may now be admitted to the United States free of duty under paragraph 686 of said tariff act. The revocation of the department's ruling (T. D. 31775) is not to be construed as applying to the so-called Bungo sulphur, which in the opinion of the department, is dutiable as refined sulphur under paragraph 81 at the rate of $4 per ton.[1]

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[1] See letter of Assistant Secretary of the Treasury (T. D. 31962) to Collector of Customs, Portland, Oreg., dated Oct. 28, 1911. Treasury Decisions, vol. 21, 1911, p. 5.

In the following table the importation of sulphur for consumption is given for the last five years:

Sulphur imported and entered for consumption in the United States for the calendar years 1907–1911, by kinds, in long tons.

Year.	Crude.		Flowers of sulphur.		Refined.		All other.[a]		Total value.
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	
1907	20,399	$355,944	1,458	$41,216	606	$14,589	60	$8,426	$420,175
1908	19,620	318,577	793	22,562	693	17,227	30	4,013	362,379
1909	28,800	492,962	770	23,084	966	26,021	53	7,565	549,632
1910	28,656	496,073	1,024	30,180	1,106	25,869	47	6,489	558,611
1911	24,200	434,796	3,891	83,491	985	24,906	68	9,643	552,836

[a] Includes sulphur lac and other grades not otherwises provided for, but not pyrite.

Statement, by countries and by customs districts, showing the imports into the United States of crude sulphur or brimstone each calendar year, 1909–1911, in long tons.

Countries whence exported and customs districts through which imported.	1909		1910		1911	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
COUNTRY.						
Canada	297	$7,235	5	$160	......	....
United Kingdom	2	58	7	199	11	$248
Italy	10,369	194,834	10,704	201,993	8,031	156,157
Japan	15,800	250,639	17,377	283,232	16,185	279,991
Other countries	446	6,188	554	10,404	23	329
Total	26,914	458,954	28,647	495,988	24,250	436,725
CUSTOMS DISTRICT.						
Baltimore, Md	5,586	105,436	4,312	80,756	1,500	28,209
Boston and Charlestown, Mass	......	....	5	121	20	480
New York, N. Y	4,601	85,059	6,817	128,794	6,531	127,948
Los Angeles, Cal	608	9,711	754	12,424	700	11,330
San Francisco, Cal	10,132	158,588	7,310	116,595	9,664	85,928
Willamette and Portland, Oreg	4,342	68,780	7,623	124,643	4,661	19,274
Hawaii	......	....	1,200	21,160	1,100	161,720
All other	1,645	31,380	626	11,495	74	1,836
Total	26,914	458,954	28,647	495,988	24,250	436,725

EXPORTS.

In 1909 the United States exported 37,142 long tons of sulphur, valued at $736,928; in 1910 the exportation amounted to 30,742 long tons, valued at $552,941; in 1911 the exports amounted to 28,103 long tons, valued at $545,420. The excess of imports over exports amounted in 1911 to only 1,041 tons in quantity and to but $7,416 in value—figures which indicate that the United States is providing ample sulphur for the domestic demand.

OCCURRENCE.

LOUISIANA.

The sulphur deposits of Louisiana and the methods by which they are worked have been briefly described in this chapter in previous years. The process employed in mining Louisiana sulphur is known as the Frasch process from the inventor, Herman Frasch. In view of this great achievement, as well as of many others in the field of applied chemistry and chemical technology, the Perkin medal for distinguished service was awarded to Mr. Frasch on January 19, 1912, on behalf of the Perkin medal committee of the Associated Chemical and Electrochemical Societies of America.

In the address of acceptance at the time the medal was awarded, Mr. Frasch gave the history leading up to the discovery and the exploitation of Louisiana sulphur. Mr. Frasch's account was followed by a paper on the geology of the sulphur and sulphur oil deposits of the Coastal Plain, by A. F. Lucas, and by another on the sulphur mines of the Union Sulphur Co. in Louisiana, by F. H. Pough, from whose article the material given below is mainly taken.[1]

Sulphur mine is located 3 miles from the town of Sulphur, Calcasieu Parish, La., a town of about 1,000 inhabitants located on the Southern Pacific Railroad. The sulphur deposit was discovered in 1865 in boring for petroleum and was found to underlie a layer of quicksand several hundred feet in thickness. The sulphur and associated beds, which are some hundreds of feet in thickness, extend to a depth of 1,100 feet or more. The sulphur is associated with limestone, which is impregnated to an extent of 70 per cent more or less with sulphur. The sulphur beds are underlain by gypsum. As shown by test borings, the sulphur deposit at the locality worked is sharply defined and nearly circular in shape and has a diameter of more than half a mile.

The sulphur is melted by means of superheated water and then pumped from the ground in liquid form. To superheat the water used in the pumping there are now on the grounds 130 boilers of 150 to 300 horsepower each. "These boilers are arranged in eight batteries containing with one exception 15 to 20 boilers each. Each battery of boilers is capable of operating a well. As a rule, two batteries are placed in a group so that one foreman can oversee both. The boilers are fired entirely with fuel oil and only three men, two firemen and one water tender, are needed on each shift to attend to the firing and the feed water in each battery." The consumption of fuel oil amounts to 700 barrels per day in each battery when operating at full capacity and more than 1,000,000 barrels of fuel oil are used each year.

The average daily consumption of water is about 7,000,000 gallons and the problem of heating to the proper temperature this vast quantity of water required for the operation of the wells was a difficult one but was solved by the ingenuity of Mr. Frasch. The pumps and superheaters are located in the rear of each battery. The superheaters are vertical cylindrical receptacles about 4 feet in diameter and 16 feet high containing a series of shallow trays over which water pours and is thus brought into intimate contact with live steam from the boilers. The total boiler capacity is 25,000 horsepower and a unique feature of the plant is that a very small part of the steam is used for power.

The enormous amount of water required for the boilers and superheaters is provided for by means of a pumping station located on the Houston River about 6 miles from the mine. This pumping station contains a centrifugal pump having a capacity of 12,000,000 gallons per day and the water is carried to the mine by means of a private canal. To supplement the pumping station and provide against breakdowns, there is an artificial storage reservoir covering 150 acres.

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[1] Jour. Ind. and Eng. Chemistry, February, 1912, pp. 134-147.

The wells are sunk in groups, the individual wells being placed 50 to 100 feet apart, and one well will sometimes produce as high as 400 to 500 tons of sulphur per day and keep up a steady flow for months at a time—in one case the output from a single well reached 73,000 tons. One well is now producing (January, 1912) considerably more than 500 tons a day and has been thus producing for some weeks. The average output is over 250,000 tons per year but the only limitation is the market demand.

The liquid sulphur as it flows from the well is so pure that the company is able to guarantee a sulphur content of 99½ per cent. But the average purity is well above that figure. The sulphur is collected and stored in large bins about 150 by 250 feet made by setting posts into the ground and nailing to them 2 inch by 12 inch planks of suitable length. The sulphur is delivered into the center of these bins and caused to spread in thin layers about one inch thick which cool so rapidly as to permit continuous operation. A separate bin is used for each well in order to permit accurate measurement of the output which is carefully taken and recorded daily. As the bed of sulphur grows in thickness the sides of the bins are raised by means of additional uprights and planking until they reach a height of 60 feet or more. When a bin is filled, another is built along side of it so that continuous blocks of sulphur may be formed several hundred feet in length by 150 feet or more in width and from 60 to 65 feet in height. Blocks of sulphur have thus been formed containing as much as 150,000 tons.

When it is desired to ship the sulphur, a movable track is laid as a spur from the main line, parallel to the long side of the bin. The boards from this side are then removed and the sulphur thrown down by means of blasts placed near the bottom of the pile. The sulphur is then picked up and loaded into cars by means of locomotive cranes fitted with grab buckets capable of handling two tons at a time and loading a 35-ton car in 14 minutes. Shipments from the mine have frequently reached 1,000 tons per day for periods of 20 to 30 consecutive days.

A large quantity of sulphur is shipped directly from the mine in closed cars which are loaded by box car loaders, but by far the largest portion of the sulphur is shipped by rail in open, bottom-dump cars to Sabine, Texas, in trains of about 20 cars, where it is loaded into steamers for distribution along the Atlantic coast and for export to Europe.

The loading plant at Sabine has a capacity of from 600 to 800 tons per hour and the facilities are such that it is possible for a 7500-ton steamer to dock, load, and sail within 12 hours. * * *

The sulphur is handled at Sabine by means of cranes and grab buckets similar to those used at the mine, which deliver the sulphur into hoppers from which it falls upon a rapidly moving system of belts which carry it to the dock and up an incline to a height of about 10 feet above the steamer's deck. From the inclined belt it falls into an adjustable iron chute in the form of a pipe which telescopes, from which it drops into the hold of the steamer. By turning this iron chute from side to side it is practicable to load the cargo so evenly that no trimming is required in the steamer or vessel designed for carrying bulk cargoes.

TEXAS.

It is reported that a New York syndicate headed by S. M. Swenson & Sons has bought a large sulphur-producing property aggregating about 10,000 acres, on the west side of Brazos River, at its mouth, and will soon install a complete sulphur mining plant and at the same time build a port city.

Plans are already under way involving a town site, docks, warehouses, terminal property for railways, a bank, and a hotel. The necessary machinery and equipment have been contracted for and are now en route to the field.

SULPHUR DEPOSITS OF SUNLIGHT BASIN, WYOMING.[1]

Location.—The sulphur deposits described are located in the upper part of Sunlight Basin, Park County, Wyo., about 32 miles in a direct line northwest of Cody and 14 miles east of the east boundary of Yellowstone National Park. There is a fair wagon road from Cody, from which the distance is 52 miles, but the deposits are inaccessible owing to a steep hill, the ascent over which amounts to about 2,000 feet i 2 miles.

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[1] Hewett, D. F., Bull. U. S. Geol. Survey No. 530, 1912.

Deposits.—The sulphur deposits occur in seven isolated groups, six of which lie in belt about 3½ miles long, which crosses the valley of Sunlight Creek. The other depos is situated on Little Sunlight Creek, about 4 miles northeast. Prospecting has bee limited to digging numerous shallow trenches and pits, none of which has penetrate more than 12 feet below the surface.

The six groups lie in an approximately straight line and each i located on the slope of a ridge, practically adjacent to a ravine. Th sulphur deposits are irregularly distributed in areas of the bleache igneous rocks, and are devoid of vegetation and in contrast to th well-wooded slopes surrounding them. The positions of the group of sulphur deposits are determined by a broad zone of intricate fracturing on a small scale.

Sulphur occurs in two forms—

Cementing surface débris and incrusting irregular open fractures in the lava. Th first mode of occurrence is more widespread superficially than the second, but exploration has shown that the sulphur-bearing débris is merely a mantle covering smal areas in which sulphur is found in the second form. The sulphur occurs as a clea lemon-yellow incrustation, the surface of which is covered with numerous minut crystals.

The débris is of local origin and has been set free by weathering an washed to the lower slopes. It is almost certainly not more than 1 feet thick at any place. Sulphur fills the interstitial spaces of th débris in varying degree, impregnating the mantle very irregularly The largest area in which sulphur is found in this condition is slightl in excess of 2 acres, but most of the deposits are less than half an acr in extent.

Though no analyses have been made, inspection indicates that those portions of th débris nearest the present surface are richest, the maximum content of sulphur bein about 60 per cent. The débris lying on bedrock generally contains much less sulphur the amount varying with the thickness of the entire cover of the débris, but as a rul not exceeding 10 per cent.

Small pieces of wood associated with the deposit are impregnate with sulphur, but there is no evidence of replacement of wood fibe by sulphur. The odor of hydrogen sulphide was detected near ever deposit and carbon dioxide has apparently accumulated in the botto of most of the pits and trenches.

In the second mode of occurrence * * * the sulphur occurs as a clear yellow incrustation upon the walls of open fractures in the lava and as an impregnation in the partly or wholly decomposed rock near these fractures. The incrustation varies from a small fraction of an inch to 3 inches in thickness and is practically pure sulphur, but the impregnated rock does not generally contain more than 10 per cent of sulphur and would probably average considerably less when considered in large masses.

At several places there are roughly conical mounds, the largest being 20 feet in diameter and 5 feet high, composed of angular fragments of andesite heavily incrusted with sulphur. The rock surrounding these mounds contains only a trace of sulphur. The accumulation of sulphur is greatest at the center of the mounds, whence hydrogen sulphide and carbon dioxide issue freely and where sulphur is probably forming at the present time. The size of these mounds indicates the small areal extent of this second mode of occurrence of sulphur when compared with the overlying mantle of sulphur-bearing débris.

Genesis.—It is believed that the sulphur deposits have formed from the decomposition of hydrogen sulphide rising through irregular fractures in the lava flows. This decomposition probably took place according to the well-known reaction $2H_2S+O_2=2H_2O+2S$. The amount of sulphur deposited in the bed rock lava is small, owing apparently to the inability of the relatively dry gases to replace or dissolve siliceous rocks. * * * The high-grade sulphur-incrusted débris on the surface is due apparently to the exceptional conditions favoring the aeration and oxidation of the gases. It is thought that each deposit of this character covers one or more vents from which the sulphur-bearing gases are escaping.

Alum and gypsum are present and are thought to be due to the reaction between the sulphuric acid formed by the complete oxidation of the hydrogen sulphide with the bases of the igneous rocks.

The deposits are thought to be of relatively recent origin, probably being wholly postglacial. In one of the mounds the dead root of a cedar tree, similar to those growing near by, penetrates the fractured sulphur-bearing rock in such a manner as to make it certain that the tree once grew there. It is believed that here the sulphur is of very recent origin.

Production.—No sulphur has been produced from these deposits and it is extremely improbable that they will be sources of production until the transportation facilities of the region are greatly improved.

The amount of sulphur existing in the surface débris is capable of easy demonstration, but it is not thought to be great compared with that in workable deposits of sulphur in general. The maximum content of sulphur in material of this class can not exceed 50 per cent in large amounts of material, as it is governed by the pore space of loosely-packed slide rock, which seldom exceeds 40 per cent. The amount of sulphur existing below this superficial cover is undoubtedly very much less, owing both to the relatively poorer chance for oxidation of the sulphurous gases and to the small amount of open space available for the deposition of sulphur. The occurrence of sulphur is distinctly superficial and it is not thought that the deposits will become important.

SULPHUR DEPOSITS IN SAN RAFAEL CANYON, UTAH.[1]

Location.—The sulphur deposits in San Rafael Canyon, Utah, are located 18 or 20 miles west of Green River, Utah, and about 5 miles from the mouth of the canyon of San Rafael River. The canyon is about a quarter of a mile wide where the sulphur deposits occur and at least a dozen sulphur springs emitting hydrogen sulphide are present.

Deposits.—The sulphur springs on the canyon side issue from impure limestone débris which apparently overlies a thin bed of the same rock. The ground is impregnated with sulphur above the springs. Part of the sulphur is present in the form of small crystals, but a larger part is amorphous and of a pale dirty-yellow color. The limestone is partly altered to gypsum near where the sulphur is found. The sulphur has evidently formed from the oxidation of hydrogen sulphide according to the reaction $2H_2S+O_2=2H_2O+2S$. Further oxidation to sulphuric acid accounts for the gypsum, which has resulted from the reaction between the limestone and the acid. From the origin assumed, it is inferred that the deposits are shallow and small.

The sulphur-bearing strip is only 100 or 150 feet wide and 750 feet long. Some trenches have been dug, but they do not show much. Under the existing conditions, namely scarcity of fuel, a 20-mile haul to railroad, and a restricted market, it is doubtful whether the deposits can be profitably worked. The origin of the hydrogen sulphide is not definitely known, but it is suggested that it may come from igneous exhalations or from sedimentary beds in which organic matter is reacting with metallic sulphides.

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[1] Hess, F. L., Bull. U. S. Geol. Survey No. 530, 1912.

SULPHUR DEPOSITS OF MINERAL COUNTY, COLO.[1]

Location.—The two sulphur deposits described are located in Mi eral County, Colo., about 25 to 30 miles southwest of Creede and i the southeastern part of the San Cristobal quadrangle of the Unite States Geological Survey. Both deposits occur in volcanic rocks Miocene age.

Trout Creek deposit.—The Trout Creek deposit is about 25 mil southwest of Creede and is reached from that town by wagon road.

The sulphur rock is remarkably well banded and except for the presence of sulph the specimens resemble well-bedded tuff. The bands are less than half an inch wi and are either drab or yellowish gray. Narrow bands or lenses of yellow sulphur an of gray chalcedony are present. Yellow sulphur also lines fractures in the ore. Th drab bands have a conchoidal fracture and a vitreous luster and burn readily. Th yellowish gray bands have a dull luster and resemble siliceous sinter. Some of th ore consists of brecciated fragments of the banded ore cemented by similar materia Thin sections of the ore show that the drab bands are nearly pure sulphur in ve minute crystals, and the yellowish-gray bands are opal in which are imbedded nume ous minute crystals of sulphur. The yellow sulphur is more coarsely crystalline an is probably secondary.

A determination of sulphur on an average sample of the material taken from the o bins * * * showed 63.4 per cent sulphur and no selenium. The remaining 36 per cent is almost pure silica, as it showed a residue of less than 0.1 per cent on ignitio after treatment with hydrofluoric and sulphuric acid.

The deposit is on a northwesterly fissure which appears to be an extension of a fau clearly exposed only 2 miles northwest of the main deposit.

Some of the bodies of sulphur rock exposed in the surface pits appear to have fille irregular, nearly vertical underground openings, but this could not be definitel determined. The material is often fractured and recemented. The banding irregular, but it was thought on the whole to be nearly vertical. The available da on the deposit as exposed in the tunnels, however, indicate that it is a surface depos about the opening of a series of hot springs arranged along the northwesterly faul The sulphur rock exposed in the tunnels appears to be irregular in thickness and som what discontinuous. The greatest observed thickness was about 16 feet.

The underground workings are an upper and a lower tunnel wit drifts and shafts. There is also a reduction plant which was operate a short time, but it is believed that little or no sulphur was placed o the market from these deposits. In the reduction the sulphur roc was loaded on steel cars which were run into a cylindrical retort an the sulphur melted out by steam under pressure.

Middle Fork sulphur deposit.—The Middle Fork sulphur deposit i located about 5 miles south of the workings on Trout Creek, on th south side of the Continental Divide. It occurs at an elevation 11,000 feet in the flat basin at the head of the west branch of th Middle Fork of Piedra River. So far as could be observed, the deposi is associated with a zone of intense but irregular alteration which run about N. 20° W.

Sulphur was found in two places, only a few hundred yards apart. The uppe exposure has been uncovered for about 10 feet just south of the creek by a surfac prospect. Its contacts are not exposed and but little could be learned of its relation The sulphur-bearing mass is in all respects similar to that of the deposits in Trou Creek.

Genesis of the ore.—The typical banded ore is made up almos entirely of sulphur and opaline or chalcedonic silica, and is free fro sulphates, sulphides, or carbonates. The similarity of the ore to tha known to be derived from hot springs points to the latter or geyse action as the most probable mode of origin. It is believed that th sulphur was deposited from a colloidal solution, as was also the silica brought up from below. The cryptocrystalline character of the sulphur, the opaline character of the silica, the intimate association of the two, the banding of the ore, and the absence of other minerals, particularly sulphates and carbonates, favor this view.

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[1] Larsen, E. S., and Hunter, J. F., Bull. U. S. Geol. Survey No. 530, 1912.

Probable extent of the deposits.—The surface deposits of hot springs have not, as a rule, great persistency, but are commonly formed as a number of lenslike deposits, more or less closely related. The size of such individual deposits may vary greatly and their form would in general be lenticular but in detail very irregular. The deposits within the vents of such springs would be irregular in form and the sulphur would probably not continue to a great depth.

SULPHUR DEPOSITS NEAR SODA SPRINGS, IDAHO.

Location.—The sulphur deposits near Soda Springs, Idaho, have been described by R. W. Richards and J. H. Bridges.[1] They are located 5 miles east of the town, which is on the Oregon Short Line in Bannock County, in T. 9 S., R. 43 E. A considerable amount of sulphur was produced from the deposit in 1901 and 1902, but work was subsequently abandoned and the plant was dismantled.

Deposits.—Sulphur deposits have been mined on the north side of Sulphur Canyon in the SE. ¼ SW. ¼ and the SW. ¼ SE. ¼ sec. 2 and the NE. ¼ NW. ¼ and the NW. ¼ NE. ¼ sec. 11, and on the south side of Wood Canyon in the SE. ¼ SE. ¼ sec. 11 and the NE. ¼ NE. ¼ sec. 14. A small amount of prospecting has been done in sec. 13, but apparently no sulphur has been mined. The greater part of the excavation in both groups of workings has been done 50 to 200 feet above the level of the present springs. Both quarrying and tunneling were employed in developing the deposits. About 2,000 cubic yards had been excavated in the open work. The condition of the tunnels was such that an examination of them was impossible, so that no idea was gained of the extent of the underground workings, which are reported, however, to comprise several hundred feet. The plant for the separation of the sulphur from the gangue was located on the Wood Canyon side of the divide.

The sulphur, associated with small crystals of gypsum, occurs as the cement of a fault agglomerate or breccia composed of fragments of tuff, limestone, and quartzite. The tuff is composed of angular fragments of volcanic glass and makes up the most conspicuous part of the agglomerate. It is snow white and apparently does not weather to a nourishing soil, and the barren character of its outcrop was noted by the early explorers. It is wholly probable that the gases exhausted by the rock crevices in the immediate vicinity have also the effect of stunting, retarding, or even destroying plant and animal life. Dead rabbits and birds bore ample evidence to this fact. The principal indication of the age of the tuff is gained from the age of the faulting, which is of course inferred from a broader view of the region than can be had in this particular area. The age of these particular faults is not evident more definitely than that they are post-Triassic, but by comparison with other parallel faults, of which the Cokeville fault [2] can be taken as a type, they may be and probably are late Cretaceous. The fact that the tuff forms a prominent part of the fault agglomerate is taken to indicate that it is pre-Cretaceous in age and not to be correlated in any way with the late basaltic flows of the vicinity.

The sulphur is found in small pyramidal crystals lining cavities and in crystalline and amorphous masses in the interstices of the breccia. The crystallinity is shown by the spherical radiating figure formed upon some surfaces obtained by breaking, and the smooth to conchoidal fracture on other surfaces serves to indicate the amorphous variety. A rather spectacular form of occurrence in stalactites in vertical crevices in the breccia was noted in the south wall of the quarry on the Wood Canyon side of the divide. This variety has almost a canary-yellow color on fresh fracture, but on exposure changes rapidly to a dull submetallic gray. The gray color of much of the lower grade ore is apparently due to a thin coating of similar material. The air bubbles which are included in the stalactitic sulphur may indicate that the sulphur was exuded in a fluid state rather than deposited from solution. An unsatisfactory attempt was made to estimate the percentage of sulphur contained in the ore and the conclusion reached—that the run of the quarry face would average 10 per cent native sulphur—must be accepted with caution, for it depends entirely on observation an inference.

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[1] Bull. U. S. Geol. Survey No. 470, 1911, pp. 499–503.

[2] Bull. U. S. Geol. Survey No. 430, 1910, p. 506.

Alum is reported by Mr. James Call, of Soda Springs, as present in the ore, but non was found by the writers.

Method of smelting the ore.—The ore from these deposits was smelted by the Wester Sulphur Co., of Duluth, Minn., in a plant located near the deposits, but the compan failed, although the equipment appears to have been well selected and well installec It consisted of two coal-burning boiler units, a battery of five or six cylindrical retort and a crushing plant. The system of smelting consisted of introducing the hanc sorted ore in perforated iron cars of about half a ton capacity into a retort which woul hold one car at a time, melting the sulphur from the gangue by the introduction c steam into the retort, and drawing off the sulphur into suitable molds. The sulphu cake was then put through a crusher and grinder and reduced to a fine powder an bagged. The condition of the gangue in the dump indicated that the recovery, thoug not perfect, was up to the standard usually set for the method used.

Outlook.—The failure of an apparently well-backed attempt to develop thes deposits will render improbable any further attempts in the immediate future. It i extremely doubtful if the deposits can be profitably worked by a process giving a complete recovery of the values, even to supply the local demand, in competition with th relatively high-grade deposits of Wyoming and Utah.

FOREIGN SULPHUR DEPOSITS.

SULPHUR MINES IN SAN LUIS POTOSI, MEXICO.[1]

According to United States Consul Wilbert L. Bonney—

> The great bulk of Mexican sulphur is obtained from the mines near Cerritos, in th State of San Luis Potosi, about 50 miles east of the State capital. The deposit is on of the largest and richest in the world.
>
> The production of the mines is about 800 metric tons (a metric ton equals 2,204. pounds) of refined sulphur per month. The sulphur is encountered at a depth of 2 feet below the surface, and the lowest present workings are 190 feet deep. The mine are at an elevation of about 5,800 feet above sea level. The indications are that th sulphur extends downward indefinitely in chimney form. The ore runs 37 to 90 pe cent pure and is smelted by the steaming process. Of the product, about one-thirc finds a market in Mexico, the present price being about $32 per metric ton. Th mines employ about 700 men. The property is owned by the Virginia-Carolin Chemical Co., an American concern, but is under lease to German interests. Th excess over home market demands is shipped to Germany.
>
> There are traces of sulphur in other parts of the State, and sulphur compounds ar common among the ores. At Venado, about 50 miles north of San Luis Potosi, a sulphu deposit has been uncovered, but its output is small compared with that of the Cerrito mines. The Venado deposit lies in a blanket form about 10 feet wide, practically or the surface, and the product shows about 30 per cent pure sulphur. The operating company had its ovens installed by an Italian expert after the manner of the Italian smelting practice, but the capacity of the works does not exceed from 3 to 4 tons a day under favorable circumstances.

PYRITE.

PRODUCTION.

The production of pyrite in the United States in 1911 amounted to 301,458 long tons, valued at $1,164,871. This is an increase in quantity of 59,846 long tons and in value of $186,893, as compared with the production of 1910, which was 241,612 long tons, valued at $977,978. The figures are also the maximum ever recorded by the Survey for the pyrite industry. Though low-grade sulphide ores of copper containing considerable quantities of pyrite and pyrrhotite, from Ducktown, Tenn., and elsewhere, and zinc sulphide concentrates from the Mississippi Valley as well as from Western States, have been used in recent years in the manufacture of sulphuric acid, this condition of affairs does not seem to have curtailed the output of pyrite, as it was feared it might. As a matter of fact, the output of pyrite has shown a great increase during the last five-year period, and this has been a period of rapid development of the by-product sulphuric acid industry. It is estimated that the quantity of sulphides other than straight pyrite used in the manufacture of sulphuric acid in 1911 is equivalent to about 200,000 long tons of pyrite, which would bring the tonnage of this mineral theoretically produced in 1911 up to slightly more shan 500,000 long tons. This does not include copper-bearing Spanish pyrite used in making suplhuric acid.

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[1] Daily Cons. and Trade Rept., Jan. 23, 1912.

In the following table is given the production of pyrite in the United States by States during the last three years:

Production of pyrite in the United States, 1909–1911, by States, in long tons.

State.	1909			1910			1911		
	Quantity.	Value.	Average price per ton.	Quantity.	Value.	Average price per ton.	Quantity.	Value.	Average price per ton.
Alabama	[a]15,848	[a]$77,291	[a]$4.88	....	....	.....	....	....	.....
California	51,266	254,235	4.96	27,158	$129,504	$4.77	48,415	$182,787	$3.78
Georgia	(a)	(a)	(a)	(b)	(b)	(b)	6,223	26,155	4.20
Indiana	(c)	(c)	(c)	(c)	(c)	(c)			
Missouri	....	....	.....	....	....	.....			
Oklahoma	....	....	.....	....	....	.....			
Illinois	[c]8,332	[c]23,046	[c]2.77	[c]10,502	[c]33,747	[c]3.21	17,441	47,020	2.70
Massachusetts	[d]47,987	[d]221,299	[d]4.61	38,978	187,071	4.80	[e]59,215	[e]282,373	[e]4.77
New York									
Ohio	9,461	29,003	3.07	3,766	12,831	3.41	6,471	18,017	2.78
Pennsylvania	(d)	(d)	(d)	....	....	.....	(e)	(e)	(e)
Virginia	114,176	423,283	3.71	[b]148,653	[b]565,358	[b]3.80	150,800	558,494	3.70
Wisconsin	(d)	(d)	(d)	12,555	49,467	3.94	12,893	50,025	3.88
Total	247,070	1,028,157	4.16	241,612	977,978	4.05	301,458	1,164,871	3.86

[a] Georgia production included with Alabama.
[b] Georgia production included with Virginia.
[c] Indiana production included with Illinois.
[d] Production of Pennsylvania and Wisconsin included with Massachusetts and New York.
[e] Pennsylvania production included with Massachusetts and New York.

The production of pyrite in the United States since 1882 is given in the following table:

Production of pyrite in the United States, 1882–1911, in long tons.

Year.	Quantity.	Value.	Year.	Quantity.	Value.
1882	12,000	$72,000	1897	143,201	$391,541
1883	25,000	137,500	1898	193,364	593,801
1884	35,000	175,000	1899	174,734	543,249
1885	49,000	220,500	1900	204,615	749,991
1886	55,000	220,000	1901	[a]241,691	1,257,879
1887	52,000	210,000	1902	[a]207,874	947,089
1888	54,331	167,658	1903	[a]233,127	1,109,818
1889	93,705	202,119	1904	207,081	814,808
1890	99,854	273,745	1905	253,000	938,492
1891	106,536	338,880	1906	261,422	931,305
1892	109,788	305,191	1907	247,387	794,949
1893	75,777	256,552	1908	222,598	857,113
1894	105,940	363,134	1909	247,070	1,028,157
1895	99,549	322,845	1910	241,612	977,978
1896	115,483	320,163	1911	301,458	1,164,871

[a] Includes production of natural sulphur.

IMPORTS.

The importation of pyrite still greatly exceeds the domestic supply as appears from the following table:

Imports for consumption of pyrite containing not more than 3.5 per cent of copper, 1907–1911, in long tons.

Year.	Quantity.	Value.	Year.	Quantity.	Value.
1907	627,985	$2,581,787	1910	803,551	$2,748,647
1908	668,117	2,624,339	1911	1,006,310	3,788,803
1909	688,843	2,428,580			

WORLD'S PRODUCTION OF PYRITE.

In the following table is given the world's production of pyrite and the quantity of pure sulphur which it is supposed to replace in the market, estimated on the assumption that the pyrite averages 45 per cent of sulphur:

World's production of iron pyrite and quantity of sulphur displaced, 1906–1910, in long tons.

Country.	1906	1907	1908	1909	1910
Spain	186,262	222,274	259,308	254,853	(a)
France	261,084	278,214	280,233	268,918	(a)
Portugal [b]	345,222	359,413	[c] 80,135	[c] 194,861	(a)
United States	261,422	247,387	222,598	247,070	241,612
German Empire	193,869	193,259	216,000	195,560	(a)
Norway	194,770	[c] 232,321	[c] 264,891	[c] 278,352	(a)
Greece	....	....	6,759	14,506	(a)
Hungary	110,849	97,936	97,268	97,412	(a)
Italy	120,437	[c] 124,926	[c] 129,647	[c] 130,152	(a)
Canada	35,365	[c] 41,288	[c] 42,264	[b] 57,718	48,098
Newfoundland	28,132	19,920	....	(a)	(a)
Russia	20,344	21,551	57,760	(a)	(a)
Servia	....	....	32,211	21,286	(a)
Turkey	[d] 34,449	[d] 62,008	[e] 57,707	(a)	(a)
United Kingdom	11,140	10,194	9,448	8,429	9,380
Bosnia and Herzegovina	13,262	7,115	10,238	7,151	(a)
Belgium	894	391	351	211	211
Sweden	21,483	26,686	29,103	15,850	(a)
Japan	3,540	55,281	33,334	21,170	(a)
Total	1,842,524	2,000,164	1,829,255	1,813,499	....
Sulphur displaced [f]	829,136	900,074	823,165	816,075	....

[a] Statistics not available.
[b] Includes cupreous iron pyrites.
[c] Cupreous iron pyrites.
[d] Exports.
[e] Year ending March, 1908.
[f] Based on estimated 45 per cent of sulphur content.

PYRITE INDUSTRY BY STATES.

ALABAMA.[1]

Pyrite has been mined near Pyriton, Clay County, Ala., but during the last two years the deposits have been idle. The town is located on the Atlanta, Birmingham & Atlantic Railroad, in the north-central part of the county. The deposits which have been worked lie just south of the railroad and appear to trend with the schists which enclose them. Two mines are located close to the station, and two others are situated about 1 mile to the west. What is known as the No. 1 or Smith mine is located opposite Pyriton station. It was worked by means of an incline, now filled with water, except close to the surface where the rock is so badly decomposed that the relationship between schist and ore cannot readily be made out. From material seen in the ore bins and on the dumps, the pyrite does not appear to constitute a true vein but occurs in the form of highly pyritic layers interbanded in quartz-chlorite schists. Most of the schist carries scattered pyrite grains, which in some layers are very abundant and in others constitute practically the whole of the rock. Pyritic layers wedge out parallel to the schistosity and their places are taken by schist. Small quartz stringers and hornblendic bands are not uncommon in the schist. The strikes observed range from approximately northeast to east, with dips of 25°–30° S. The mill which formerly belonged to the mine has been torn down and the mine itself has been out of commission for some time. The No. 2 or Williams mine is located about a quarter of a mile west of Pyriton station. The incline or shaft is filled with water and none of the ore in place could be seen. The material observed on the dump is similar to that at the Smith mine and indicates that the two mines may have worked the same pyritic zone. The third mine is located near the railroad and about 1 mile west of Pyriton. It was also under water when visited. Like the others, it was formerly worked by an inclined shaft. The fourth mine is located a short distance southwest of the third mine.

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[1] From notes furnished by E. S. Bastin.

CALIFORNIA.

California ranked third in 1911 in the production of pyrite, being exceeded by Virginia and New York. The increase in production of the State was notable as compared with the production in 1910. Part of the California pyrite mined is used in the manufacture of sulphuric acid by the companies producing it. California pyrite came from near Oakland and Fruitvale, Alameda County, and from near Keswick, Shasta County.

GEORGIA.

The production of pyrite in Georgia in 1911 decreased as compared with 1910. The pyrite mined came from Villa Rica, Carroll County, about 30 miles west of Atlanta.

N. P. Pratt, of Atlanta, Ga., published recently an account of the Chestatee pyrite deposit[1] which it is thought will be developed at an early date and which is hence of considerable prospective importance to the fertilizer industry of the South Atlantic and adjacent States.

The property is owned by the Chestatee Pyrites Co. and is located on both sides of Chestatee River in the southeast corner of Lumpkin County, in the Dahlonega district, about 18 miles from Gainesville, on the Southern Railway. The holdings consist of 744 acres in fee simple and all riparian rights in an additional 158 acres, the latter so selected as to control the water-power possibilities of Chestatee River from its junction with the Tessentee to a point 2½ miles down stream.

The surface of the property has a general elevation of about 250 feet above the Southern Railway tracks at Gainesville, and if it is decided to manufacture sulphuric acid at the mines, it could be delivered through an iron pipe by gravity to tank cars at Gainesville.

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[1] The American Fertilizer, Aug. 26, 1911, pp. 44c–44h.

Chestatee River, which flows through the entire length of the property, adds greatly to its value, as its fall and drainage area indicate a potential water power ample for all the requirements of mining and milling operations. It is calculated that the water rights of the company will permit the development of a minimum of 471 electrical horsepower, 24 hours service, at its mining and milling site.

The vein strikes N. 44° 20′ E. and dips 54° NW. Its outcrop, which is persistent, is everywhere visible in the strike line for a distance of 5,800 feet southwest from the river. In the first 3,600 feet of this distance the outcrop is seen in its original position owing to its location on a hillside, as a consequence of which erosion has left it exposed. For the remainder of the distance it is represented by gossan and no effort has yet been made to uncover it. North of the river very little decomposed ore shows on the surface, but the vein is traceable from the float gossan. Beginning at the river and going southwest a distance of 2,000 feet the outcrop rises sharply along the side of the ridge to a height of 262 feet above river level.

Considerable time and money have been spent in determining the character and extent of the vein and in securing other information required for its proper development. These investigations have been confined to that portion of the vein running southwest from the river for a distance of 2,100 feet. This part of the vein was exposed in places by surface crosscuts and thus its continuity over the entire distance was proved.

The salient geologic features of the deposit have been described by E. C. Eckel.[1] According to Eckel the pyrite forms a bedded vein and is conformable with the quartzose mica schists overlying it on the west. The rock adjoining the pyrite on the east is the type of hornblende schist associated with the Dahlonega gold veins, and as at Dahlonega the pyrite body occurs on the contact between a normal (and possibly sedimentary) mica schist and a hornblende schist, which is a much metamorphosed igneous rock of early date.

At the time of Eckel's visit the prospecting shaft had been sunk to a depth of 150 feet. Subsequently it was sunk to a depth of 228 feet when the owners, satisfied with the outlook, discontinued operations until such time as transportation for the ores could be assured. A part of the development work done subsequently to that visit has already been outlined.

> In addition at a point 500 feet southwest of the river, and at an elevation of 226 feet above water level, a tunnel has been driven, crosscutting the ore body about 50 feet below the surface. This revealed a thickness of vein from wall to wall of 38 feet of high-grade ore. On the hanging-wall side, but in the ore body, a drift was run 32 feet to the northeast. On the footwall side, also in the ore body, another drift was run 86 feet to the southwest, and at this point joins the shaft which was sunk at an angle of 54° to the northwest. The total thickness of the vein as shown here was also about 38 feet. At the 100-foot level the vein was again crosscut, showing a thickness from wall to wall of 31 feet, and at this level, also on the hanging wall side, a drift was made to the southwest, but in the ore body, a distance of 165 feet. Though the shaft was carried on farther to a total depth of 228 feet, no further crosscutting of the vein below the 100-foot level has been made.[2]

In addition a total of 1,250 feet of diamond drilling has been effected, 6 holes having been sunk in different positions with a distance of 900 feet between the extreme positions.

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[1] Bull. U. S. Geol. Survey No. 213, 1903, p. 62.

[2] Pratt, N. P., The American Fertilizer, Aug. 26, 1911, pp. 44c–44h.

The result of the underground crosscutting and diamond drilling has proved the vein to be persistent, and that while its average thickness is scarcely less than 30 feet, like all veins of this character, it is irregular in thickness, varying between wide extremes, the greatest thickness encountered being 40 feet, the least 4 feet 6 inches.

Both walls are firm and are exceedingly well defined, presenting themselves with sharp abruptness to the vein material. High-grade ore chutes occur throughout the vein in such way that sometimes the entire thickness is high-grade hard lump ore from wall to wall, which in a few hundred feet gives way to low-grade ore equally persistent from wall to wall.

[From the explorations already made, it has not been possible to determine] the probable width and length and direction of the high-grade ore lenses, nor can the ratio between the high-grade or lump ore and the lower-grade or concentrating ore be intelligently estimated at this time. [It can be said, however,] that the lowest grade of ore which has been encountered averages from wall to wall, a pyrite content of 51 per cent by weight, all of which is true bisulphide of iron. It is probable, however, that the average of that part of the vein which is not high-grade lump ore will yield 80 per cent of its weight in high-grade fine ore to intelligent concentration. No pyrrhotite or monosulphide appears anywhere in connection with this vein. The gangue is comparatively a light micaceous material, with very little silica, thus rendering milling and concentration of the lean ores an easy operation.

From the cross tunnel first described above, 8 carloads of lump ore were extracted and shipped to an acid plant for practical demonstration in the manufacture of sulphuric acid. Upon receipt at the works, each carload was carefully averaged and analyzed. The composite of the eight analyses is as follows:

Moisture	0.36
Sulphur	43.52
Iron	39.70
Copper	3.09
Zinc	.72
Alumina	2.53
Magnesia	.43
Arsenic	None
Sand and insoluble matter	9.26

The practical demonstration of the burning of the ore at this plant, where it was used exclusively for about 6 weeks in the operation of the works, revealed remarkably satisfactory burning qualities. The freedom with which it gave up its sulphur, as well as its apparent tendency not to clinker, made the actual working of the furnace under it most satisfactory, while the chamber drips during the entire operation were remarkably clear, due, of course, to the absence of arsenic, as shown in the preceding analysis.

Concerning the low-grade or concentrating ore, which appears to constitute the larger part of the vein from wall to wall, several investigations were made to determine the availability of the pyrite contents to simple concentration. The methods adopted will not be described, except to say that the quantity of low-grade ore which averaged about 70 per cent pyrite by weight was shipped to Colorado and there treated in a modern concentration mill. The result of the treatment was that this ore, crushed to 12 meshes per lineal inch, yielded at one operation a total of 92 per cent of its pyrite contents, which contained by analysis 45.54 per cent of sulphur. It is understood that there will be no difficulty in saving a large part of the remaining 8 per cent at some little increased cost; but matters of this kind remain for practical demonstration when the concentration plant has been completed and the economies of its operation fixed. As is well known, modern practice in concentration has been greatly simplified in operation and greatly increased in efficiency in the last few years. Confidence, therefore, is felt that, with a modern milling plant for the concentration of the lower grade ore, the development of the water power, insuring the cheapest operation possible, and with rail transportation secured for the shipment of its product, the Chestatee pyrites property is capable of yielding large tonnages of high-grade lump ore as well as high-grade fines for practically an indefinite period.[1]

ILLINOIS.

The production of pyrite in Illinois in 1911 increased about 104 per cent as compared with the production in 1910, and the value of the output showed an increase of nearly 67 per cent. This State ranked fourth among the States for the year, being exceeded by Virginia, New York, and California in the order named. The pyrite is obtained entirely as a by-product in the mining of coal.

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[1] Pratt, N. P., op. cit.

INDIANA.

The production of pyrite as a by-product in the mining of coal in Indiana declined greatly in 1911 as compared with 1910, and the production in this State has been falling off during the last four years.

MASSACHUSETTS.

The production of pyrite in Massachusetts in 1911 came from the old Davis mine operated by the Davis Sulphur Ore Co. The shipments made during the year were from Charlemont, the nearest railroad connection, and represented concentrates obtained from milling the old waste dumps. During the early summer of 1910 the Davis mines were exhausted and the company started to rob the pillars with the result that the mine collapsed, presumably closing it for all time. Since that time the company has been active recovering ore from the dumps. The methods employed were outlined in this report for 1909, to which the reader is referred for more complete information.

NEW YORK.

The pyrite mined in New York in 1911 came from St. Lawrence County and was produced by two companies, the St. Lawrence Pyrites Co. and the Hinckley Fiber Co., the former working mines at Stellaville, near Hermon, and the Hinckley Fiber Co. working the Cole mine north of Gouverneur and using the output chiefly in the manufacture of sulphite fiber at Hinckley.

The pyrite deposits of this part of New York are associated with gneisses, schists, and crystalline limestones—the same series which include the hematite ores of St. Lawrence and Jefferson counties. The pyrite is generally associated with quartz, hornblende, feldspar, and other minerals, forming a lean ore—a condition of affairs which has militated against their exploitation on a larger scale in spite of their favorable situation with respect to market. This leanness of the ore has necessitated the installation of expensive milling machinery.

According to D. H. Newland[1]—

> recent experiments in the use of low-grade pyrite for sulphite manufacture are said to have been successful and to have demonstrated that ores carrying but 25 or 30 per cent of sulphur can be economically employed if obtainable at low cost. Under such conditions there should be opportunity for enlarging the output from the deposits which are within easy shipping distance of the Adirondack sulphite mills. According to a leading manufacturer in that section, the output of sulphite fiber by the local plants amounts to about 900 tons a day, for which 135 tons of commercial sulphur at an average cost of $3,300, are consumed. An output of from 400 to 600 tons of pyrite of the grade found in northern New York would be required to supply the equivalent of that amount of sulphur.

OHIO.

Pyrite in Ohio is produced as a by-product in connection with the mining of coal. The output in 1911 increased greatly as compared with that of 1910, but not so much as it otherwise would have done on account of strikes which kept some of the mines closed during six or more months of the year. The production of the State even under the most favorable conditions is not large.

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[1] The mining and quarry industry of New York State: Bull. New York State Mus. No. 151, 1911.

The average price of pyrite per ton in Ohio is somewhat low. This is owing to the fact that at some of the collieries it is sold at a nominal figure to parties who make a business of cleaning it and disposing of it to the chemical factories. The operation of cleaning it is somewhat tedious and expensive, and some of the coal operators not caring to handle it dispose of it very cheaply.

OKLAHOMA AND PENNSYLVANIA.

A small quantity of pyrite was produced in both Oklahoma and Pennsylvania in 1911. In Pennsylvania the pyrite was obtained in connection with the mining of coal.

VIRGINIA.

As heretofore Virginia led in the production of pyrite in 1911, the output of the State exceeding in both quantity and value the returns for 1910. The pyrite is mined principally in Prince William, Louisa, and Pulaski counties. In this report for 1909 extended descriptions were given of the more important operations in the counties mentioned, and for details the reader is referred to that publication which is still in print and available for distribution.

WISCONSIN.

The production of pyrite in Wisconsin increased slightly in 1911 as compared with 1910. The production is obtained by electrostatic and electromagnetic separation from zinc blende and the methods have been described in former volumes of Mineral Resources in the reports on zinc.

THE SULPHURIC-ACID INDUSTRY IN THE UNITED STATES.

GENERAL USES.

For the first time in the history of the volume "Mineral Resources" published by the Geological Survey a brief statistical statement is made this year of the sulphuric-acid industry. One of the reasons for adding the subject of sulphuric acid to the chapter on sulphur and pyrite is that owing to the fact that so large a percentage of the output of the two latter substances is converted into acid for use in the industries, the acid production becomes in a way a check on the statistics of sulphur and pyrite, especially of pyrite, which is practically all used in the acid industry. Another reason for collecting the statistics of sulphuric acid is because it is a commodity so extensively used in the manufacture of other chemicals that it has come to be regarded as a criterion or gage of the activity of the country in chemical manufactures in general. Sulphuric acid is probably used for a greater variety of purposes in the chemical arts than any other substance.

According to Lunge[1] the principal applications of sulphuric acid are the following:

1. *In a more or less dilute state (say from 144° Twad. downward).*—For making sulphate of soda (salt cake) and hydrochloric acid, and therefore ultimately for soda ash bleaching powder, soap, glass, and innumerable other products. Further, for superphosphates and other artificial manures. These two applications probably consum nine-tenths of all the sulphuric acid produced. Further applications are for preparing sulphurous, nitric, phosphoric, hydrofluoric, boric, carbonic, chromic, oxalic, tartaric citric, acetic, and stearic acids; in preparing phosphorus, iodine, bromine, the sulphates of potassium, ammonium, barium (blanc fixe), calcium (pearl-hardening) especially also for precipitating baryta or lime as sulphates for chemical processes sulphates of magnesium, aluminum, iron, zinc, copper, mercury (as intermediate stage for calomel and corrosive sublimate); in the metallurgy of copper, cobalt, nickel platinum, silver; for cleaning (pickling) sheet iron to be tinned or galvanized; for cleaning copper, silver, etc.; for manufacturing potassium bichromate; for working galvanic cells, such as are used in telegraphy, in electroplating, etc.; for manufacturing ordinary ether and the composite ethers; for making or purifying many organic coloring matters, especially in the oxidizing mixture of potassium bichromate and sulphuric acid; for parchment paper; for purifying many mineral oils, and sometimes coal gas; for manufacturing starch, sirup, and sugar; for the saccharification of corn for neutralizing the alkaline reaction of fermenting liquors, such as molasses; for effervescent drinks; for preparing tallow previously to melting it; for recovering the fatty acids from soapsuds; for destroying vegetable fibers in mixed fabrics; generally, in dyeing, calico printing, tanning, as a chemical reagent in innumerable cases; in medicine against lead poisoning, and in many other cases.

2. *In a concentrated state.*—For manufacturing the fatty acids by distillation; purifying colza oil; for purifying benzene, petroleum, paraffin oil, and other mineral oils for drying air, especially for laboratory purposes, but also for drying gases for manufacturing processes (for this, weaker acid also, of 140° Twad., can be used); for the production of ice by the rapid evaporation of water in a vacuum; for refining gold and silver, desilvering copper, etc.; for making organo-sulphonic acids; manufacturing indigo; preparing many nitro compounds and nitric ethers, especially in manufacturing nitroglycerin, pyroxylin, nitrobenzene, picric acid, and so forth.

3. *As Nordhausen fuming oil of vitriol (anhydride).*—For manufacturing certain organo-sulphonic acids (in the manufacture of alizarin, eosin, indigo, etc.); for purifying ozokerite; for making shoe blacking; for bringing ordinary concentrated acid up to the highest strength as required in the manufacture of pyroxylin; and for other purposes.

PRODUCTION.

The statistics of sulphuric acid have previously been collected at each census, beginning with the census of 1870; and at the censuses of 1889, 1899, and 1904 the quantity and value of each of the important grades were ascertained. The statistics of production for the years prior to 1911 have been taken from the census reports for 1889, 1899, and 1904.[2]

Under the production for 1911 all sulphuric acid is given regardless of whether it was sold as such or consumed in the factories where it was made. It is well known that nearly all the sulphuric acid made at fertilizer works is there consumed in the manufacture of superphosphates, that in factories where explosives are manufactured the sulphuric acid is combined with nitric acid and is used in making nitroglycerin and gun cotton, and that, finally, in petroleum refineries much of the acid is consumed in refining the crude oil. In the earlier census reports the sulphuric acid consumed in establishments where manufactured and that produced by establishments engaged primarily in the manufacture of other products was listed separately, which is not done in the Survey's report for 1911, except in the case of the sulphuric acid manufactured at smelters as a by-product, which has been separately listed as will be seen from page 23.

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[1] Manufacture of sulphuric acid and alkali, vol. 1, pt. 2, ed. 1903, pp. 1169–1170

[2] Census of Manufactures, 1905, Bull. 92, p. 15 et seq.

Sulphuric acid is produced in several grades—(1) 50° Baumé acid, also known as chamber acid, containing an average of 51.04 per cent SO_3, or 62.53 per cent H_2SO_4; (2) 60° Baumé acid, containing an average of 63.7 per cent SO_3, or 78.04 per cent H_2SO_4; (3) 66° Baumé acid, known as oil of vitriol, containing approxmately 79 per cent SO_3, or approximately 97 per cent H_2SO_4. Higher strengths of acid usually contain SO_3 dissolved in sulphuric acid, for example, pyrosulphuric acid and fuming or Nordhausen acid. Oleum is a grade which contains 30 per cent of free SO_3, or a total of 87.14 per cent of free and combined SO_3.

In the following table the quantity and value and price per ton are given of the three main grades of acid together with similar data for other strengths of acid combined. With the exception of the small quantity of acid included under "Other grades," the output is also expressed in terms of 50° Baumé acid for the sake of comparison.

Production of sulphuric acid in the United States in 1889, 1899, 1904, and 1911, by grades, in short tons.

Grade.	1889.			1899.		
	Quantity.	Value.	Price per ton.	Quantity.	Value.	Price per ton.
50° Baumé	504,932	$4,307,067	$8.53	953,439	$7,965,832	$8.35
60° Baumé	10,190	122,940	12.06	17,012	246,284	14.47
66° Baumé	177,267	3,249,466	18.33	382,279	6,035,069	15.78
Total	692,389	7,679,473		1,352,730	14,247,185	
Total reduced to 50° Baumé acid	[a] 783,569			[b] 1,548,123		9.20

Grade.	1904.			1911.		
	Quantity.	Value.	Price per ton.	Quantity.	Value.	Price per ton.
50° Baumé	1,169,141	$8,314,646	$7.11	1,026,896	$5,447,958	$5.31
60° Baumé	48,688	581,523	11.94	421,165	2,624,042	6.23
66° Baumé	411,165	5,917,699	14.38	751,541	9,176,297	12.21
Other grades	[e] 13,268	361,018	27.20	[f] 10,728	121,575	11.33
Total	1,642,262	15,174,886		2,210,330	17,369,872	7.86
Total reduced to 50° Baumé acid	[c] 1,869,437			[d] 2,688,456	17,313,822	6.44

[a] Includes 290,768 tons, for which no value was assigned, consumed in establishments where manufactured; and also sulphuric acid produced by establishments engaged primarily in the manufacture of other products.

[b] Includes 764,355 tons, with an assigned value of $7,032,066, consumed in establishments where manufactured; and also sulphuric acid produced by establishments engaged primarily in the manufacture of other products.

[c] Includes 968,445 tons, with an assigned value of $7,232,675, consumed in establishments where manufactured; and also sulphuric acid produced by establishments engaged primarily in the manufacture of other products.

[d] Exclusive of acids of strength greater than 66° Baumé.

[e] Reported as oleum by the census for 1904.

[f] Includes acid of 53° and 63° Baumé, which accounts for the lower valuation per ton of this acid as compared with 66° acid.

Similar figures of production of sulphuric acid for 1909 are not presented, for the reason that the complete classification of the acids of different strengths has not been published by the Census. The totals for 1909, however, may be compared. The production in that year, both for sale and for consumption, was 2,748,527 tons of 50° Baumé acid, an excess of 60,071 tons as compared with the production of 1911, which was 2,688,456 tons. This latter figure, however, does not include 3,486 tons of acid of greater strengths than 66° Baumé which it has been found impracticable to reduce to 50° Baumé owing to the uncertainty about the exact specific gravities of these stronger acids. As compared with the figures of the earlier censuses, namely those for 1899 and 1904, the increases are of great magnitude. The comparative diminution in the value of the acid in 1911 is worthy of note and is of the greatest importance because of the extensive use of sulphuric acid in the manufacture of other products.

UTILIZATION OF SULPHUR-BEARING GASES.

The gases and waste products issuing from the flues of smelters, roasters, blast furnaces, reverberatory furnaces, and converters, are made up chiefly of dust, the oxides of sulphur, carbon dioxide, and nitrogen. The flue dust may be caught by mechanical means before leaving the stack, but the gases pass into the atmosphere unless they are converted into other products, as, for example, sulphur dioxide and sulphur trioxide into sulphuric acid. These two gases are the most troublesome and, on account of their deleterious action on vegetation, they have caused almost endless litigation in some parts of the country where they were formerly allowed to pour forth into the atmosphere. The higher oxide of sulphur, sulphur trioxide (SO_3), makes up but a small fraction of the smelter and furnace gases, but sulphur dioxide (SO_2) issues in large volumes and travels great distances. Various methods have been adopted to overcome its evil effects. One of these methods is to dilute the gases by mixing them with sufficient air to meet the requirements of the law before their discharge into the atmosphere; another is to build the stacks so high that the gases on discharging will travel long distances and become thoroughly mixed with air before their descent to the ground. Neither of these methods has worked satisfactorily in practice. In view of this fact, processes have been devised whereby these waste sulphur gases may be converted into sulphuric acid or into sulphur. The conversion of sulphur gases into sulphuric acid is practiced at Ducktown, Tenn., and a description by F. B. Laney of the process of manufacture is given farther on.

A process of separating sulphur also from these gases has recently been tried experimentally at Campo Seco, Cal., and is briefly described by Frank L. Wilson [1]—the process being that of Prof. S. W. Young, of Leland Stanford Junior University.

The principle of the process is very simple. It is necessary to have present some reducing agent to combine with the oxygen of the sulphur dioxide. The passage of the sulphur gases over red-hot carbon, in the form of coke, has been tried, but this process was found to be expensive and only partly successful. In the thiogen process, so called by Prof. Young, an oil spray is used in the presence of a catalyser or catalytic agent. The catalyser may be either ferric oxide or calcium sulphide, and in laboratory experiments the reactions are especially rapid when the oxide of iron is present. When free oxygen is present in the gases it must be taken care of before the hydrocarbon of the oil will take up the oxygen of the sulphur dioxide. It is better to clean the gas as much as possible and to concentrate it before allowing it to pass to the combustion chamber.

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[1] Experiments with the thiogen process: Min. and Sci. Press, Apr. 6, 1912, pp. 497–498. See also Min. and Sci. Press, Sept. 3, 1911, pp. 386–387.

At the roasters at Campo Seco, the vaporization of the oil is accomplished by steam-injected burners. The spray of oil is directed into the combustion chamber, beyond which is a reaction or contact chamber filled, as is the combustion chamber, with a checkerwork of brick. The spaces in the contact chamber are nearly filled with a mixture of equal volumes of plaster of Paris and sawdust wet with water, to which a small quantity of iron salts is added. The sawdust burns out and the sulphate of calcium quickly reduces to calcium sulphide, the mass shrinking to about half of the space between the bricks. Condensing chambers are necessary in which to collect the liberated sulphur. For the latter inverted V-shaped pipe is used, each condenser having a sloping floor with a trap door. To obviate contaminating the sulphur with selenium, arsenic, or antimony, compounds of which may be present in the ore, low, broad, slightly inclined condensing chambers may be used in which water sprays cool the gases below the temperature at which these elements volatilize. These elements are deposited on projecting tiles placed in the walls of the chamber for that purpose, while the sulphur having the lowest temperature of volatilization passes on and is caught in the regular condensing chamber. Thus far three trial runs have been accomplished at Campo Seco.

PRODUCTION OF SULPHURIC ACID FROM SMELTER GASES.

In the following table is given the quantity of sulphuric acid recovered from the gases from smelters throughout the United States. By comparison with the preceding table it will be observed that this is 20 per cent of the total sulphuric acid produced in the United States [1] during the year 1911; also, as already indicated on page 13, that the sulphuric acid produced from this source is equivalent to about 200,000 long tons of pyrite.

Production of sulphuric acid from copper and zinc smelters in 1911, in short tons.[a]

	60° Baumé acid.		Price per ton.
	Quantity.	Value.	
Copper smelters	207,657	$1,056,185	$5.09
Zinc smelters	230,643	1,677,511	7.27
Total	438,300	2,733,696	6.24
Total acid reduced to 50° Baumé	547,875		

[a] The acid reported to the Survey includes that of 50°, 53°, 60°, and 66° Baumé strengths. All strengths have been reduced to both 50° and 60° Baumé, as given in the table.

The figures given in the table, however, do not include acid manufactured from copper-bearing Spanish pyrite.

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[1] Percentage based on the total 50° acid, namely, 2,688,456 tons.

THE MANUFACTURE OF SULPHURIC ACID FROM SMELTER FUMES AT DUCKTOWN, TENN.[1]

By F. B. Laney.

GENERAL STATEMENT.

There are few industries of more importance to the South than the manufacture of sulphuric acid. This industry is so closely connected with the manufacture of fertilizers that a plentiful and cheap supply of acid means a cheaper and a more readily available supply of fertilizers, so necessary in the building up of the depleted soils. The States of Tennessee, South Carolina, and Florida have large deposits of rock phosphate the value of which is in a measure determined by a cheap and regular supply of sulphuric acid. The greatest demand for sulphuric acid is in the fertilizer industry; the greatest supply of raw materials for this industry is in the Southern States; and the greatest demand for fertilizers is also in this same section.

Another equally important item in the consideration is the fact that the sulphuric-acid plants at Ducktown use what was, until their establishment, not only wholly a waste product of the smelters, but also a menace to all the adjacent country. Thus these acid plants have produced at least three desirable results (1) they furnish a large supply of acid where it is most needed; (2) they render valuable large supplies of sulphur hitherto worthless and, according to the annual report of the Tennessee Copper Co., thus more than double the net profit per ton of ore;[2] and (3) they relieve the surrounding country of the menace of the smelter fumes, thus making it possible to continue operating the mines and at the same time to cultivate the surrounding lands.

PROCESSES OF MANUFACTURE OF SULPHURIC ACID.

THE CONTACT PROCESS.

There are two processes to-day employed in the manufacture of sulphuric acid, one known as the contact process and the other as the chamber process. The contact process depends upon the catalytic action of spongy platinum and ferric oxide (Fe_2O_3) in changing sulphur dioxide (SO_2) to the higher oxide (SO_3), and is a very efficient method when clean gas is available. Flue dust and other impurities from the average furnace are very deleterious to the contact mass and soon render it inert or destroy it. On this account this process is not widely used in this country, and not at all in connection with smelters.

THE CHAMBER PROCESS.

The chamber process is more adaptable to varying conditions, is not so badly affected by flue dust and impurities, and is therefore most largely used in this country.

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[1] This paper is based largely on data collected in connection with geologic work by the writer in the Ducktown district.

[2] Ann. Rept. Tennessee Copper Co., New York, 1909, p. 6.

The following account of the chamber process is condensed from Thorp:[1]

The process consists in bringing together under suitable conditions, sulphur dioxide, oxygen, and water vapor, in the presence of certain oxides of nitrogen. The latter probably act as carriers of the oxygen, causing it to unite with the sulphur dioxide to form sulphur trioxide which combines with water to form the acid.

THE RAW MATERIALS.

The raw materials employed in sulphuric acid making are: (1) Sulphur: (*a*) Crude brimstone; (*b*) metallic sulphides, such as iron pyrite, chalcopyrite (copper pyrite), sphalerite (zinc blende), etc.; (*c*) Hydrogen sulphide (seldom used). (2) Sodium nitrate, or nitric acid. (3) Water as steam. (4) Oxygen as air.

The acid may be made from brimstone, pyrite, blende, or hydrogen sulphide, but they are not used together.

REQUISITES.

The requisites for an acid plant of the chamber type are: Suitable roasters or furnaces, nitrating or niter pots, one or more Glover towers, coolers, lead chambers, Gay-Lussac towers, acid hoists or blow cases, the necessary flues, connections, stacks, and storage tanks for the acid.

Since the burners and chambers employed for one source of sulphur can not be adapted to that of another without extensive alterations, the manufacturer must decide what material he will use and erect his plant accordingly.

In using sulphide ores as the source of the sulphur the first requisite is a suitable roasting furnace or burner. The object sought is a steady uniform supply of pure sulphur dioxide gas at a uniform temperature, together with as complete desulphurization of the ore as can be had. It is undesirable to use any more fuel in the burning than is absolutely necessary, since the carbon dioxide generated in the combustion of the fuel is very undesirable in the towers and chambers of the plant. Some burner is therefore adopted which will, so far as possible, continue the combustion by the heat generated from the burning of the ore itself, after it has been started by a small amount of fuel. A number of such furnaces are in use, among the most satisfactory of which may be mentioned the Wedge mechanical furnace and the Herreshoff burner. The furnaces or burners deliver their gases into a single large flue which serves also as a dust chamber. Here the dust, etc., from the burners settles and its carriage into the plant is obviated.

In one or more of the burners, or in some other suitable place, are set the necessary niter pots. In these the needful oxides of nitrogen are generated by the action of sulphuric acid on sodium nitrate. Sometimes the niter pots are placed so that the oxides of nitrogen generated in them enter the main flue just before it reaches the Glover tower.

The Glover tower has a number of functions. It serves to set free the oxides of nitrogen in the acid which comes to it from the Gay-Lussac towers; it cools the burner gases before they reach the leaden chambers; it furnishes part of the water vapor needed in the chambers; and it may be called upon to concentrate the dilute acid from the chambers. Some acid is also formed in this tower as the gases pa through it on their way to the chambers. It is made of sheets lead burned together and supported on a suitable framework metal or timber. It is lined within with acid-resisting bricks la without mortar, and is filled with lumps of quartz or vitrified brick Its size depends upon the capacity of the plant, but it is usuall from 20 to 30 feet high and 10 or 12 feet in diameter. At the top an apparatus for distributing the acid which comes to it from th Gay-Lussac towers and other sources. The gases from the burne enter this tower from the bottom and pass out at the top throug a flue or pipe which carries them on into the chambers.

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[1] Thorp, F. H., Outlines of industrial chemistry, 2d ed., New York, 1909, pp. 46–62.

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This process of acid making is very sensitive to changes in temperature, volume, concentration, and purity of the gases. A little irregularity in any one or more of these factors will result in a decrease in the "make" of acid or a loss of nitrogen, either of which increases the cost of manufacture very materially. This is the reason that, until recently, there have been few successful attempts to utilize smelter fumes, especially those from blast furnaces, in the manufacture of sulphuric acid.

THE ACID PLANTS AT DUCKTOWN.

From the foregoing statements one may easily understand some of the difficulties that confronted the two copper companies operating in the Ducktown district when a few years ago, on account of a court decision, they found on their hands the problem of disposing of the fumes from their smelters in a way that would not injure vegetation in the surrounding territory. Both were smelting large quantities of ore—the Tennessee Copper Co. handling about 400,000 short tons and the Ducktown Sulphur, Copper & Iron Co. about 150,000 short tons annually. In addition to the necessity for handling larger quantities of gas than had ever before been attempted in acid plants, there were the problems to solve of irregularity of supply of gas, variable temperatures, large quantities of flue dust, and, finally, considerable and variable quantities of carbon dioxide gas, in part derived from the ores themselves and in part from the limestone and coke used in the furnace charges.

TENNESSEE COPPER CO.

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The plant as it now stands is the largest sulphuric acid plant ever built. It comprises two octagonal Glover towers 50 feet high and 30 feet in diameter, with suitable niter pots at the base of each; a flue 10 by 20 by 120 feet from the Glover towers to cooling chambers; 64 cooling chambers 10 feet 10 inches by 10 feet 10 inches and 70 feet high and 8 cooling chambers 10 feet 10 inches by 20 feet and 70 feet high; 4 hard lead fans, each with capacity of 67,000 cubic feet of gas per minute; 12 chambers 50 feet by 50 feet and 70 feet high; 6 chambers 50 feet by 50 feet and 75 feet high; 8 chambers 23 feet by 50 feet and 80 feet high, having a total volume of 4,600,000 cubic feet; 4 Gay-Lussac towers 23 feet by 23 feet and 50 feet high; 4 octagonal Gay-Lussac towers 19 feet in diameter and 70 feet high and 2 octagonal Gay-Lussac towers 36 feet in diameter and 65 feet high; acid coolers, pumps, and hoists; and 15 storage tanks with a capacity of 15,000 tons of acid.

In the construction of this plant 50,000 square feet of asphaltum were put in for flooring under the chambers; nearly 1,500,000 chemical brick, about 300,000 fire brick, and nearly 2,500,000 red brick were used in flues and connections; nearly 8,000 tons of quartz for packing the towers; over 500,000 pounds of asbestos in insulating flues; and nearly 8,000,000 pounds of lead in chambers, towers, etc.

In a general way the chambers are of conventional design, but the enormous volume of fumes received and of acid produced have brought about developments new to the acid industry. Among the most notable of these is the size of gas connections, acid lines, acid coolers, and fans, all of which are on a scale never before known. Other developments of importance are means for screening the "fines" from the ores; the erection and operation of a Messiter ore-bedding plant; an increase in size and number of the Gay-Lussac towers; changes in blast-furnace top so as to deliver a uniform supply of gas; the construction of a dust chamber 26 feet by 36 feet and 163 feet long, in which are arranged sets of baffles so as to secure a large dust precipitation; and the construction of an electric acid hoist.

It was discovered that a material decrease in fuel needed in the furnace charge could be made by screening out the fine material from the ores. This also permits a higher oxidation in the furnaces and consequently a higher percentage of sulphur dioxide in the gases.

By means of the bedding plant the furnaces are served with a uniform charge, and at the same time it has been possible to reduce the carbonaceous fuel by about 20 per cent, thereby lowering the troublesomely high temperature of the gases and also reducing the percentage of carbon dioxide in the gases from 5 to about 4 per cent.

One of the expensive items in the operation of an acid plant is the loss of nitrogen. The object of the Gay-Lussac tower is to prevent such loss. The exceptionally large towers which were erected in 1910 have proved to be efficient far beyond original estimates in the recovery of the oxides of nitrogen.

The furnace top[1] in use before this acid plant was built, the standard brick top supported by structural steel, was found to be unsatisfactory when the gases had to be dampered back to force them into Glover towers. After much experimental work a simple type of furnace which works very satisfactorily was devised. It has

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Emmons, N H., Copper blast-furnace tops: Trans. Am. Inst. Min. Eng., vol. 41, 1910, pp. 723–738.

cast-iron corner posts and dividers with walls and ends of fire brick. The half circle top is supported on 20-inch **I**-beams resting on columns and all metal parts as far as possible are exposed to the cooling influence of outside air. The important features are the large elbow and the flue, 9 feet in diameter, leading to the dust chamber. Flues, elbows, and half circle tops are made of boiler plate with magnesia blocks between the metal and the lining of fire brick.

The dust chamber serves two purposes, it allows a large part of the flue dust to settle, and it conserves and regulates the heat of gases, delivering them at the base of the Glover towers at steady temperature and uniform pressure.

The electric acid hoist has proved itself a very valuable adjunct in raising the acid to the top of the high towers. It is simply a large lead-lined bucket arranged somewhat as a Kimberley skip, electrically controlled throughout. It is believed that this method will effect a saving over the usual blow-case or "acid egg" method. However, it is not intended to supplant the blow cases with the hoist, but to use it with them.

With the enlarged and improved equipment now in operation the Tennessee Copper Co. finds that all the ore from its mines is needed to furnish sufficient gas to keep the acid plant up to full capacity. This means that all the gas produced by the green ore furnaces must go to the acid plant, thus completely abating the smoke nuisance.

DUCKTOWN SULPHUR, COPPER & IRON CO.

That the ultimate utilization of the sulphur of their ores was the intention of the Ducktown Sulphur, Copper & Iron Co. at its organization in 1891 seems clear from its name. The problem was a difficult one and much time was spent in experimental work. The difficulties were finally overcome, and the company is to-day operating on a satisfactory basis a plant with an estimated capacity of 160 short tons of 60° Baumé acid daily. The following description of the plant is condensed from an article by W. H. Freeland and C. W. Renwick[1] and another by Wilbur A. Nelson.[2]

The plant consists of 2 Glover towers 12 feet square and 45 feet high; a series of dust chambers; 4 leaden fans; 16 chambers 96 feet long, 22 feet 8 inches wide, and 30 feet high, having a total volume of 1,050,000 cubic feet; 6 Gay-Lussac towers; and the necessary equipment for operating the plant.

From the furnaces the gases pass through flues into a dust chamber. From this chamber they pass into and rise through a cylindrical tower, thence through a kite-shaped flue to a special dust catcher on a higher level. This dust catcher with its system of flues is of especial importance in that it controls and regulates the temperature of the gases delivered to the Glover towers and also serves to eliminate the zinc and other light dusts.

From the dust catcher a brick flue runs the full length of the tower building with offtakes to each Glover tower. In these offtakes are placed the niter pots. There is also an auxiliary set of niter pots at the end of the dust catcher for emergency use. In addition to these there are also special methods of handling the nitrogen compounds.

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[1] Smeltery smoke as a source of sulphuric acid: Eng. and Min. Jour., vol. 89, 1910, pp. 1116-1120.

[2] Op. cit., pp. 30-32.

The gases, having been cleaned and reduced to the proper temperature, enter the bottom of the Glover towers. Upon reaching the top of these towers, the gases are led downward through a system of pipes to the base of a special tower through which they ascend and from which they pass through two large lead flues into the chambers. In these towers fully 40 per cent of the SO_2 is converted into SO_3. The concentration of the chamber acid is also accomplished here, and no concentrating pans are needed.

Between the Glover towers and the chambers are located the four large leaden fans which force the gases through the system. The fans are placed in two units of two fans each. One unit forces the gases into the front chambers and the other withdraws them from the rear chambers.

From the chambers the gases pass, as in all acid plants of this type, into the Gay-Lussac towers in which the nitrogen compounds are recovered in the usual way.

This company complies with requirements of the State of Georgia by holding its smelting on a basis to meet the capacity of the acid plant. The ore treated contains from 14 to 19 per cent of sulphur, averaging about 16 per cent.

It may be stated that although this plant is rated at a normal capacity of 160 tons of 60° Baumé acid a day, this does not represent the maximum, as, when actually necessary, it has attained a capacity of over 200 tons a day.

BARYTES.

By W. C. Phalen.

PRODUCTION.

The production of crude barytes in the United States in 1911 was 38,445 short tons, valued at $122,792. Compared with the production of the preceding year, which was 42,975 short tons, valued at $121,746, this was a decrease of 4,530 tons in quantity but an increase of $1,046 in value. Thus the average price per ton reported to the Survey in 1911 was higher than in 1910, being $3.19 compared with $2.83. The price of barytes given represents that paid to the miner for his crude ore, hand cobbed, sorted, and ready for shipment to the mills. This price is not intended to include the cost of wagon, boat, or railway haulage, and it is believed that in the main the values for 1910 and 1911 were reported on this basis. The price of the crude material f. o. b. mines reported by most of the principal producers ranges higher than in 1910. The average price for the State of Missouri was $3.79 per ton, which was substantially the same as in Washington County, Mo., the principal producing county in the State. At the close of 1911 there were 6,162 short tons of crude domestic barytes unsold at the mines, according to reports from the producing districts, as compared with 5,888 tons in 1910. In Missouri an output of crude barytes was reported by 34 producers, but in the majority of cases the quantity was small. Two producers reported from each of the States of Tennessee and Virginia, and one producer reported from each of the following States: Georgia, Kentucky, North Carolina, and South Carolina. Seven firms reported refined barytes with plants located in Kentucky, Missouri, North Carolina, Tennessee, and Virginia.

The total quantity of refined barytes reported as sold by mills in 1911 was 39,611 short tons, valued at $503,867. As compared with the production in 1910, which was 38,165 short tons, valued at $475,001, this was an increase of 1,446 tons in quantity and of $28,866 in value. The average price per ton reported as received for refined barytes in 1911 was $12.72, as compared with $12.45 in 1910. Toward the end of the year wholesale prices per short ton for ordinary wholesale lots in New York were as follows: American ground, $12 to $13; floated, $16 to $17; foreign floated, $18 to $22.50.

In the following table is given the production of crude barytes in the United States from 1909 to 1911, inclusive, together with the average price per ton:

Production of crude barytes in the United States, 1909-1911, by States, in short tons.

State.	1909			1910			1911		
	Quantity.	Value.	Average price per ton.	Quantity.	Value.	Average price per ton.	Quantity.	Value.	Average price per ton.
Missouri	34,815	$119,818	$3.44	22,978	$75,598	$3.29	21,500	$81,380	$3.79
Tennessee and Kentucky	15,606	55,867	3.58	6,503	13,348	2.05	8,819	20,053	2.27
Other States [a]	11,524	34,052	2.95	13,494	32,800	2.43	8,126	21,359	2.63
Total	61,945	209,737	3.39	42,975	121,746	2.83	38,445	122,792	3.19

[a] In 1909 and 1910, Georgia, North Carolina, and Virginia; 1911, Georgia, North Carolina, South Carolina, and Virginia.

The following table gives the domestic production of crude barytes in short tons from 1882 to 1911, inclusive:

Production of crude barytes, 1882-1911.

	Short tons.		Short tons.
1882	22,400	1897	26,042
1883	30,240	1898	31,306
1884	28,000	1899	41,894
1885	16,800	1900	67,680
1886	11,200	1901	49,070
1887	16,800	1902	61,668
1888	22,400	1903	50,397
1889	21,460	1904	65,727
1890	21,911	1905	48,235
1891	31,069	1906	50,231
1892	32,108	1907	89,621
1893	28,970	1908	38,527
1894	23,335	1909	61,945
1895	21,529	1910	42,975
1896	17,068	1911	38,445

IMPORTS.

The imports of barytes for consumption during the last five years and the value of imported barium compounds, from 1909 to 1911, are given in the following two tables:

Barytes imported and entered for consumption in the United States, 1907-1911, in short tons.

Year.	Manufactured.		Unmanufactured.		Total. value.
	Quantity.	Value.	Quantity.	Value.	
1907	11,207	$96,542	20,544	$76,883	$173,425
1908	3,401	29,168	13,661	58,822	87,990
1909	3,016	25,679	11,647	29,028	54,707
1910	3,565	29,782	21,270	48,457	78,239
1911	3,147	22,083	20,214	36,643	58,726

Value of the imports of barium compounds, 1908–1910.

Barium compounds.	1909	1910	1911
Witherite, barium carbonate	$31,584	$25,229	$27,351
Barium binoxide	255,013	341,631	270,917
Barium chloride	47,352	35,614	28,896
Blanc fixe, or artificial barium sulphate	65,427	67,975	71,049
Total	399,376	470,449	398,213

Imports, especially imports of barium chemicals or compounds, were less in 1911 than in 1910. Of these barium compounds, witherite, the mineral form of barium carbonate, is admitted free of duty. It has been reported that much of the so-called witherite imported, purporting to be ground natural barium carbonate, is probably precipitated barium carbonate. In the case of the other barium products imported, there is a duty on raw (unmanufactured) barytes of $1.50 per ton, and on the prepared (manufactured) barytes of $5.25 per ton. On blanc fixe, or artificially prepared barium sulphate, there is a duty of half a cent per pound.

PRODUCTION OF BARYTES IN CANADA.

According to the preliminary report on the mineral production of Canada for 1911, revised figures for 1910 indicate that there was no production of this commodity in the Dominion of Canada during that year. The production for 1911 is given as 50 tons, valued at $400, but this figure is subject to revision.

CHARACTER.

Barytes, or heavy spar ($BaSO_4$), is composed of barium oxide (BaO), 65.7 per cent, and sulphur trioxide (SO_3), 34.3 per cent. The specific gravity of the mineral is from 4.3 to 4.6; its hardness varies from 2.5 to 3.5. It is usually a white opaque to translucent crystalline mineral about as hard as calcite, but differing from the latter by its greater specific gravity and the fact that it is perfectly inert when treated with acids. It is often found stained reddish-pink or yellow by iron oxide. The common form of the mineral is that of an aggregate of straight or slightly curved cleavable plates. It also occurs in granular, fibrous, and earthy masses, and in the form of stalactites, as well as in single and clustered crystals. In its natural form the material is rarely pure, the most common impurities being silica, lime, magnesia, and the oxides of iron and aluminum. Fine particles of galena are disseminated through some of the deposits, for instance those of Washington County, Mo. Commercial grades, as mined, carry 95 to 98 per cent barium sulphate, and 1 to 3 per cent of silica.

OCCURRENCE.

Barytes occurs in veins as a gangue of metallic ores, and also in veins in sandstone and limestone or as a replacement of limestone. Differential weathering of the limestone and barytes has given rise to deposits of the mineral embedded in residual clay. This is true of the deposits near Cartersville, Ga. The mineral has a wide range in geologic age and an extensive distribution. In the United States the principal sources are, however, limited to two districts, the Missouri district and the Appalachian district. Of these two districts, Missouri furnished between 55 and 56 per cent of the production in 1911. In that State almost the entire production came from Cole, Franklin, Jefferson, Miller, Morgan, St. Francois, and Washington counties, the last named producing more than 80 per cent of the entire output reported for the State. Among the Appalachian States, the following, named in the order of the magnitude of their production, reported an output of crude barytes in 1911: Tennessee, North Carolina, Kentucky, Georgia, Virginia, and South Carolina, the last named being a new State added to the list of those producing.

USES.

By far the greater part of the barytes produced is used as a pigment in the manufacture of mixed paints. It is also used in the manufacture of lithopone, a white pigment. In the manufacture of lithopone an intimate mixture of about 4 parts of crude barytes and 1 part of a very low ash coal is placed in a revolving furnace and kept there for two or three hours at a bright red heat, very little air being admitted. The barium sulphate is in this manner reduced to barium sulphide. From 60 to 70 per cent of the barytes used is thus converted into soluble sulphide, the rest remaining as insoluble barium carbonate. Next, the calculated quantity of barium sulphide is added in the precipitating tub to the requisite quantity of zinc sulphate solution, when an intimate mixture of zinc sulphide and barium sulphate is thrown down. This precipitate is then placed in a rotary furnace and calcined at a high temperature. The calcined mass is thrown into water, ground in stone mills, washed until the wash water is neutral, settled, filter pressed, and dried on trays in drying rooms, and finally powdered by running through a pulverizer.[1] Other uses for barytes are in the manufacture of rubber, wall paper, asbestos cement, poker chips, and in tanning leather. A use of barytes reported from Italy is in the manufacture of gorgonzola cheese in Valsassina. The cheese receives a covering in the form of a thick heavy crust of the finely ground mineral, which has the property of affording just sufficient protection from aeration.

Barium sulphate is also obtained in the precipitated form (blanc fixe) and results from the action of soluble barium salts on soluble sulphates. The specific gravity of the material, 4.2, is lower than that of the natural mineral. According to H. A. Gardner,[2] it possesses greater opacity in oil than barytes, and is of more value as a paint pigment for some purposes. One of its chief uses is as a base on which to precipitate lake colors. Barium salts are reported to be used in brickmaking in order to overcome the efflorescence of bricks.

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[1] Holley, C. D., The lead and zinc pigments, 1st ed., John Wiley & Sons, New York, 1909, pp. 26–27.

[2] Paint technology and tests, McGraw-Hill Book Co., New York, 1911, p. 60.

TRADE CONDITIONS.

In a recent article, S. Marshall Evans [1] makes an interesting statement regarding the present commercial conditions of the barytes industry, as follows:

> Barium sulphate is one of the most abundant of the base minerals found in the earth. It occurs in abundance throughout the Appalachian Mountains in the States of Virginia, West Virginia, North Carolina, South Carolina, Georgia, Alabama, Kentucky, and Missouri. The last State produces 60 per cent of the domestic product. Owing to domestic and foreign competition the market price of barium sulphate in New York and Philadelphia—the chief points of consumption in the United States—has declined from an average of from $18 to $20 per ton 10 years ago to an average of from $14 to $16 per ton at the present time. The labor costs of transportation are the chief elements of expense involved in the industry.
>
> The material is first taken from the earth by miners, transported to mills, where it is washed and ground, then subjected to a chemical bleaching treatment, washed to free the product from all trace of the several acid baths through which the material must pass, and finally it is dried and packed for the market. Notwithstanding the complicated treatment which the material receives, it sells to-day in New York and Philadelphia at 0.6 cent to 0.8 cent per pound. Crude barytes ore delivered in St. Louis costs the Missouri producers $5 per ton. Of this $5, 60 cents per ton is a freight charge, from which it will be seen that the Missouri miner receives less than one-fourth cent per pound for the labor of mining and hauling to the railroad station. The freight rate from St. Louis to New York is $4.60 per ton, and the Missouri product is equal to the best produced in the world.
>
> In the Appalachian Mountains, owing to the necessity of mining at depth with its consequent requirements of highly organized mine operations, the cost of the ore delivered at the mills is somewhat less and costs the producers from $3.50 to $4.50 at their mills. The quality of the ore, however, is more refractory and difficult of treatment. The milling cost in the mill of which I am an officer runs from $5 to $7 per ton, and of this $2 is for acid and fuel. The remainder is for labor and freight. The freight from the Appalachian and Kentucky fields averages from $3.50 to $4.50 per ton, and this Appalachian product sells in New York and Philadelphia at 0.6 cent to 0.8 cent per pound.

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STRONTIUM ORE AND SALTS.

No production of strontium ore in the United States was reported to the Survey in 1911. The imports of strontium compounds reported by the Bureau of Statistics were valued at $44, as compared with $23 in 1910. The imports for 1911 do not include the value of the strontium nitrate imported into the United States for use in so-called "red fire." The value of this material in the import tables is included in the class of chemicals, drugs, dyes, and medicines, with the designation "alkalies, alkaloids, and all combinations of, and chemical compounds, mixtures, and salts not specially provided for," the imports of which in 1911 amounted to $1,680,429.15. It is not known just how much of this value is that of strontium nitrate.

MINERAL PAINTS.

By W. C. PHALEN.

INTRODUCTION.

As heretofore, the mineral paints treated in this chapter are divided into three groups—(1) natural mineral pigments, (2) pigments made directly from ores, and (3) chemically manufactured pigments. Of these three classes the first two are included in the Survey's annual summary of the mineral production of the United States, as they represent values of crude material taken directly from the earth or material which at most has passed through simple or merely preliminary treatment. The chemically prepared pigments are not included in that statement of production because the quantity and value of the original minerals entering into their composition has, in most cases, been included elsewhere, so that the publication of the statistics of the manufactured products, including the value of the organic colors, would not only result in duplication of original quantities, but would give greater than proportionate values to the minerals concerned. Collection of the statistics of production of pigments belonging to group 3 is undertaken chiefly for purposes of comparison, since the production of the ores and metals from which these pigments were derived is also reported elsewhere in Mineral Resources—which is also true of the pigments included in group 2.

Group 1, or natural mineral paints, comprises ocher, umber, sienna, hematite, siderite, limonite, ground slate and shale, and whiting[1] (ground limestone and calcite). The principal bases of metallic paints and mortar colors are the three ores of iron, hematite, siderite, and limonite. Many other minerals or mineral products are used in the paint trade, such as asbestos and products derived from it; also asphalt, barytes, clay, graphite, gypsum, magnesite, pyrite, shells, silica, and talc, and many by-products; but these are not considered here, since most of them are reported elsewhere in this volume and for some statistics are not available.

Group 2, pigments made directly from ores, comprises zinc oxide, leaded zinc oxide, zinc lead, sublimed white lead, and sublimed blue lead.

Group 3, or the chemically manufactured pigments, comprises the chemical products, basic carbonate white lead, litharge, red lead, orange mineral, lithopone, and venetian red.

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[1] Statistics for whiting are not given in this report, as to do so would result in divulging confidential information.

The total quantity and value of pigments prepared during 1911 and considered in this report was less than in 1910. There was a decrease in the quantity and value of natural mineral paints and of chemically manufactured pigments. The pigments made from ores increased in quantity and value, but the increase was not sufficient to offset the decline in the other two groups mentioned.

Work has been continued on the paint tests conducted in various parts of the country. Certain of the results were presented at the meeting of the American Society for Testing Materials held at Atlantic City in June, 1911, and are contained in the proceedings of the society referred to in the bibliography at the end of this chapter. A brief summary of the results is included in this chapter under the heading "Paint tests." The work of the scientific section of the Paint Manufacturers' Association is being continued at the Institute of Industrial Research, in Washington, D. C., and the results of the inspection tests made in 1912 are now in press and it is expected that they will be published in a short time. The reports in press and in preparation are also mentioned at the end of this chapter.

NATURAL MINERAL PAINTS.

PRODUCTION.

The production of the natural mineral pigments in the United States in 1911 as reported to the Survey amounted to 62,739 short tons, valued at $498,821. Compared with 1910 this was a falling off. The decrease in quantity was 5,884 short tons, or slightly less than 9 per cent; the decrease in value was $28,974, or 5 per cent. The decrease in quantity was shared by all the natural pigments enumerated in the table below. The decreases recorded in ocher, umber, and sienna, and ground slate and shale, were slight; in metallic paint and mortar colors they were considerable. The table given below shows the prices per ton at the point of production of the different mineral paints. Advances are shown for metallic paint and ground slate and shale, and declines are shown for ocher, umber, sienna, and mortar colors.

Average price per short ton of natural mineral pigments, 1910–11.

	1910	1911
Ocher	$9.60	$9.35
Umber and sienna	26.31	26.09
Metallic paint [a]	6.28	7.08
Mortar color	10.82	9.66
Slate and shale	5.81	6.39

[a] Includes crude iron ore sold for paint, which accounts in part for the low value per ton.

The following table gives the production and value of the natural pigments during the last four years:

Production of natural mineral pigments, 1908–1911, in short tons.

Kind.	1908		1909		1910		1911	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Ocher	14,696	$140,439	12,458	$125,349	11,711	$112,445	11,703	$109,465
Umber Sienna	1,212	30,705	1,276	33,472	1,015	26,700	1,005	26,225
Metallic paint	14,022	156,694	20,722	201,905	29,422	184,869	25,599	181,163
Mortar colors	7,856	72,881	10,820	108,126	9,960	107,780	7,922	76,517
Slate and shale, ground	12,617	93,181	14,944	98,176	16,515	96,001	16,510	105,451
Total	50,403	493,900	60,220	567,028	68,623	527,795	62,739	498,821

OCHER.

PRODUCTION.

The production of ocher in 1911 was 11,703 short tons valued at $109,465, compared with 11,711 short tons valued at $112,445 in 1910, a decrease of only 8 short tons in quantity and of $2,980 in value. The average price per ton during 1910 was $9.60, and in 1911 it was 25 cents less, or $9.35.

The following table gives the production of ocher by States from 1908 to 1911:

Production of ocher, 1908–1911, by States, in short tons.

State.	1908		1909		1910		1911	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
California	335	$2,250	(a)	(a)	118	$1,730	(a)	(a)
Georgia	6,035	63,851	5,838	$60,971	7,011	70,388	7,395	$69,447
Pennsylvania	6,963	63,035	4,137	45,472	3,642	32,254	3,013	28,101
Vermont	188	2,050	492	4,726	609	5,935	(a)	(a)
Other States [b]	1,175	9,253	1,991	14,180	331	2,138	1,295	11,917
Total	14,696	140,439	12,458	125,349	11,711	112,445	11,703	109,465

[a] Included in "Other States."

[b] Includes, 1908, Iowa, Kentucky, and Virginia; 1909, California, Iowa, and Virginia; 1910, Iowa, Kentucky, Oregon, and Tennessee; 1911, California, Iowa, Vermont, and Virginia.

IMPORTS.

In the following table are given the imports of ocher for the last five years:

Imports of ocher, 1907–1911, in pounds.

Year.	Crude.		Dry.		Ground in oil or water.		Total.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
1907	127,117	$1,312	11,850,372	$102,194	14,482	$1,079	11,991,971	$104,585
1908	584,129	4,954	8,663,537	69,815	6,094	307	9,253,760	75,076
1909	340,593	3,501	13,337,310	106,224	17,847	939	13,695,750	110,664
1910	181,176	2,055	11,849,921	129,308	10,213	483	12,041,310	131,846
1911	128,328	1,870	11,090,798	108,205	15,406	857	11,234,532	110,932

The imports of crude and dry ocher and that ground in oil or water amounted in all to 11,234,532 pounds, or 5,617 short tons. The imports of crude and dry ocher amounted to 5,610 tons, valued at $110,075, or slightly less than half of the domestic production reported, which is supposed to be in these two forms. The value of the imported crude and dry ocher exceeded that of the domestic output by $610.

NOTES ON OCHER.[1]

Ocher is a hydrated ferric oxide permeating a clay base. It has a specific gravity of about 3.5 and a decidedly golden-yellow color. Good grades should contain 20 per cent or more of iron oxide. As viewed under the microscope and with a considerable enlargement the particles composing ocher appear flocculent and uniform.

Ocher is used as a coloring matter for tinted paints, and paints made with it as a base are often used for priming coats. It finds its most extensive use, however, as a filler in the manufacture of linoleum. Ferruginous shale is often ground and the product marketed as ocher, but unless the material is actually an ocher as defined above such product is classed under slate and shale in this chapter.

In 1911 ocher was produced in Georgia, Pennsylvania, Vermont, Virginia, California, and Iowa, the States being named in the order of their producing importance. The production of Georgia and Pennsylvania constituted nearly 90 per cent of the entire output of the country.

UMBER AND SIENNA.

PRODUCTION.

The total quantity of umber and sienna produced in the United States in 1911 was 1,005 short tons, valued at $26,225, a decrease of 10 tons in quantity and of $475 in value as compared with the production of 1910. The average price of umber and sienna per ton in 1911 was $26.09, as compared with $26.31 in 1910.

In the following table is given the production of umber and sienna in the United States from 1907 to 1911:

Production of umber and sienna, 1907–1911, in short tons.

Year.	Quantity.	Value.
1907	545	$11,304
1908	1,212	30,705
1909	1,276	33,472
1910	1,015	26,700
1911	1,005	26,225

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[1] The commercial definitions of ocher, umber, and sienna in this chapter correspond to those published by the scientific section of the Paint Manufacturers' Association of the United States, Bull. 29, 1910. See also Paint technology and tests, by H. A. Gardner, 1911, p. 62.

IMPORTS.

In the following table are given the imports of umber and sienna for the past five years:

Imports of umber, 1907–1911, in pounds.

Year.	Dry.		Ground in oil or water.		Total.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
1907	3,395,690	$26,502	2,569	$211	3,398,259	$26,713
1908	2,391,153	19,461	15,556	803	2,406,709	20,264
1909	3,104,037	26,125	4,953	256	3,108,990	26,381
1910	3,994,286	28,819	11,813	734	4,006,099	29,553
1911	3,163,614	22,025	751	87	3,164,365	22,115

Imports of sienna, 1907–1911, in pounds.

Year.	Dry.		Ground in oil or water.		Total.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
1907	2,176,566	$34,752	14,629	$864	2,191,195	$35,616
1908	1,756,273	28,407	7,621	458	1,763,894	28,865
1909	2,402,901	32,913	6,114	421	2,409,015	33,334
1910	3,048,203	46,866	6,233	453	3,054,436	47,319
1911	2,845,938	36,296	14,039	923	2,859,977	37,219

The imports in the tables are expressed in pounds. Expressed in short tons the quantity of dry umber imported amounted to 1,582 tons, considerably more than the domestic production of umber and sienna combined. The imports of dry sienna, also expressed in short tons, were 1,423 tons, making the total for both products 3,005 short tons, or 2,000 tons in excess of the domestic output. The value of the imported material was $58,321, or somewhat more than twice as much as that of the domestic production reported.

NOTES ON UMBER AND SIENNA.

Umber consists of iron and aluminum silicates, containing varying quantities of manganese oxide, which influence its color accordingly. The raw variety is drab, but becomes reddish-brown on burning. A marked percentage of large-sized particles is present in this pigment. The calcined material is referred to as burnt umber. Umber is used principally as a pigment in the manufacture of tinted paints. The only State reporting a production of this pigment to the Survey in 1911 was Pennsylvania.

Like umber, sienna is essentially composed of silicates of iron and aluminum containing manganese oxide. It contains less of the oxide than umber and is of a lighter color. Photomicrographs of burnt sienna show clearly the fine condition of the pigment, but large particles are present in the raw sienna. According to some authorities, sienna owes its color to hydrated ferric oxide, with small quantities of manganese oxide, and is an earthy pigment in its nature. This latter definition likewise applies to umber, but as stated above umber contains more manganese oxide than sienna.

Sienna is used principally as a pigment. The only State whic reported sienna in 1911 was Pennsylvania.

PRODUCTION IN PRINCIPAL COUNTRIES.

The following table gives the output of ocher and umber in certai of the principal producing countries from 1906 to 1910, inclusive, a far as statistics are available:

Production of ocher and umber in principal producing countries, 1906–1910, in short ton

Year.	United States.		United Kingdom.		France.		German Empire (B varia and Saxony).	
	Quantity.	Value.	Quantity.[a]	Value.	Quantity.[b]	Value.	Quantity.	Value.
1906	12,809	$138,834	15,915	$71,358	39,187	$275,266	24,586	$72,9
1907	14,575	157,711	16,455	70,117	36,217	423,830	1,679	5,2
1908	15,266	152,319	17,244	69,012	36,442	457,072	1,938	7,4
1909	13,064	138,553	18,271	73,873	36,971	419,321	2,554	5,8
1910	12,211	123,145	18,497	74,832	(c)	(c)	(c)	(c)

Year.	Canada.		Belgium.		Japan.		Cyprus.	
	Quantity.[b]	Value.	Quantity.[b]	Value.	Quantity.[b]	Value.	Quantity.[d]	Value.
1906	6,837	$36,955	276	$243	32	$297	2,526	$6,2
1907	5,828	35,569	220	876	331	2,531	7,301	20,2
1908	4,746	30,440	496	1,655	(c)	(c)	2,524	9,6
1909	3,940	28,093	771	1,351	(c)	(c)	3,781	20,0
1910	4,813	33,185	661	1,158	(c)	(c)	(c)	(c)

[a] Includes oxides of iron and manganese used as pigments, lubricants, etc.
[b] Reported as ocher only.
[c] Figures not available.
[d] Umber exports.

METALLIC PAINT.

PRODUCTION.

The production of metallic paint reported to the Survey in 191 was 25,599 short tons, valued at $181,163, as compared with 29,42 tons, valued at $184,869, in 1910. As stated in this chapter f 1910, the effort is being made to put the production as nearly a possible on the basis of the material entering into metallic pain and to credit it to the individual State in which it was originall mined and from which it was placed on the market. The productio of metallic paints is reported from some States mainly in terms the dry ground product, the average price per ton of which is co siderably greater than that produced in the same States as ore an sold as such to the paint mills. The maximum price, that of groun paint in Pennsylvania, was $13.13 per ton; the average price p ton, as given on a preceding page, was $7.08, showing that a larg part of the production averages considerably below the latter figur such material being that which comes on the market originally i the form of unground iron ore.

The following table gives the production of metallic paint from 1908 to 1911, inclusive:

Production of metallic paint, 1908–1911, by States, in short tons.

State.	1908		1909		1910		1911	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Maryland	(a)	(a)	431	$1,957	(a)	(a)	(a)	(a)
New York	2,924	$28,090	2,553	25,533	[b] 11,085	$32,208	[b] 7,993	$28,569
Pennsylvania	5,281	69,799	[c] 8,120	105,683	8,063	91,714	7,676	100,837
Tennessee	[a] 3,645	34,663	4,075	33,369	[a] 3,907	26,680	[a] 3,282	25,381
Wisconsin	(d)	(d)	(d)	(d)	[b] 2,057	14,916	[b] 2,048	11,258
Other States [d]	2,172	24,142	5,543	35,363	4,310	19,351	4,600	15,118
Total	14,022	156,694	20,722	201,905	29,422	184,869	25,599	181,163

[a] Maryland is included with Tennessee.

[b] Principally crude iron ore sold for paint.

[c] Includes a small quantity of Venetian red.

[d] "Other States" includes: 1908, California, Ohio, Vermont, Virginia, Wisconsin; 1909, California, Michigan, Ohio, Vermont, Washington, and Wisconsin; 1910, California, Georgia, Michigan, Missouri, Washington; 1911, Georgia, Michigan, Missouri, Virginia, and Washington.

NOTES ON METALLIC PAINT.

Metallic paint consists chiefly of red and brown iron oxides produced either by grinding natural iron oxides, either anhydrous or hydrated, or by roasting natural iron carbonate. The beds of Clinton hematite in New York, Tennessee, and Georgia, the Lake Superior red hematite in northern Michigan, and the gray siderite near Lehigh Gap, Pa., are the chief sources of the raw-ore supply. Some red iron oxide is also imported. Several other materials are also used to an important extent in the manufacture of metallic paint. Blast-furnace dust, a grayish-brown dust composed of oxide of iron and coke that is separated at many furnaces, particularly in the Pittsburgh, Pa., district, yields on grinding a seal-brown powder. In the manufacture of sulphuric acid from pyrite, large quantities of "blue billy," a purplish oxide of iron not entirely free of sulphur, is produced, and this is ground to form a paint base. Ocherous silt, deposited by water flowing from coal mines, has been roasted to a bright red color and ground for paint material. Material of this description probably carries ferrous sulphate as well as hydrated ferric oxide. Another by-product that has been utilized as a metallic paint is the residue left after extracting aluminum salts from bauxite. This residue, judged by its appearance, is a ferruginous clay, and a sample obtained from southern bauxite showed when analyzed in the Survey laboratory 54.25 per cent ferric oxide (Fe_2O_3). When roasted in a rotary kiln the product was a brick-red granular material, which was subsequently ground to powder. The material is apt to retain appreciable quantities of soluble aluminum salts, which can hardly be considered as desirable ingredients in paints, and small quantities of manganese oxide are liable to be present. It is also reported that ferrous sulphate or copperas is roasted and sold as metallic paint, although copperas finds its chief use as a paint material in the manufacture of Venetian red.

The metallic paints as considered here contain, therefore, both browns and reds. Commercially the browns are known as metallic brown and certain of the reds as Indian red. All the by-product substances can not strictly be classed in group 1, but, as a rule, the production of these materials is not reported to the Survey.

MORTAR COLORS.

PRODUCTION.

The production of mortar colors reported to the Geological Survey in 1911 was 7,922 short tons, valued at $76,517, a decrease of 2,038 tons in quantity and of $31,263 in value as compared with 1910. The average price per ton was $9.66 in 1911 as compared with $10.82 in 1910. The material entered the market first in the dry ground condition, for which the prices are given.

In the following table is given the production of mortar colors from 1908 to 1911, inclusive:

Production of mortar colors, 1908–1911, by States, in short tons.

States.	1908		1909		1910		1911	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
New York	4,124	$37,392	5,691	$53,539	5,200	$50,000	2,518	$24,723
Pennsylvania	(a)	(a)	2,662	31,416	2,711	33,752	3,248	30,442
Other States [b]	3,732	35,489	2,467	23,171	2,049	24,028	2,156	21,352
Total	7,856	72,881	10,820	108,126	9,960	107,780	7,922	76,517

[a] Included in "Other States."

[b] Includes, 1908, Maryland, Ohio, Pennsylvania, Tennessee, Wisconsin; 1909 and 1910, Maryland, Ohio Tennessee; 1911, Maryland and Tennessee.

NOTES ON MORTAR COLORS.

A wide variety of materials is used in making mortar colors, and as marketed the colors are for the most part mixtures. Chief among the substances entering into mortar colors are iron oxide, "blue billy" or the residue from burning pyrite, considerable ground slate or shale, and some culm from coal washeries. The material is used for tinting mortar, cement, and concrete, and the colors are usually of the various shades of red, brown, purple, blue, and black.

SLATE AND SHALE.

PRODUCTION.

The quantity of slate and shale ground for paints and for fillers in 1911 was 16,510 short tons, valued at $105,451, a decrease of only 5 tons as compared with the production of 1910, but an increase in value of $9,450. The average price per ton of the material in 1911 was $6.39, and in 1910 and 1909 it was $5.81 and $6.57, respectively. The explanation in part of the increase in value of the product in 1911 as compared with 1910 is that in 1911 as well as in 1909 the product was marketed entirely in the ground form, whereas in 1910 a considerable portion of it was marketed in the crude state without previous grinding.

The following table gives the production of slate and shale ground for pigment during the last five years:

Quantity and value of slate and shale, ground for pigment, 1908–1911.

1908	short tons	12,617	$93,181	1910	short tons	16,515	$96,001
1909	do	14,944	98,176	1911	do	16,510	105,451

NOTES ON SLATE AND SHALE.

Slate and shale for use in pigments and as fillers in the manufacture of oilcloth and linoleum were produced in 1911 in Pennsylvania, New York, New Jersey, Indiana, and Tennessee—named in the order of their production. Iowa, which produced in 1910, reported no output in 1911, and Indiana and Tennessee, from which nothing was reported in 1910, were among the producers in 1911.

In this chapter for 1910 there were given certain general results of studies made by B. L. Miller[1] on the paint shales of Pennsylvania. Mr. Miller divides the shales studied, which are used in the paint trade, into three classes, black, yellow, and red shales. As the detailed descriptions of these different classes of shale were not given in this chapter for 1910, it has been thought well to incorporate them here.

> *Black shales.*—Black shales, ground and sold under the name "mineral black" are extensively used in the manufacture of paint in many places in Pennsylvania. * * * They are widely distributed throughout the State, occurring in a great many formations representing every Paleozoic period. In many places the material has been dug for use in paint, and in some of the slate regions the refuse about the quarries has been shipped to paint factories. A small use has been made of the culm heaps about the anthracite coal mines and the disintegrated surface coal near the outcrop. There is a tendency for most of the black-shale material to settle out of the oil, but this is not a serious objection. The durability of the paint in which black shales have been used is vouched for by many persons who have tried it. Black shale is used to some extent in paint for buildings, but chiefly in the manufacture of a black filler for ironwork.
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> *Yellow shales.*—Yellow shales occur in many places throughout the State and at several geologic horizons, but particularly in the Martinsburg and Mauch Chunk shales. In a number of places these shales have been utilized in the manufacture of paint, and when ground fine and mixed with oil they are very serviceable. Their principal use, however, is in the manufacture of oilcloth and linoleum. They are considerably lighter in color than the ochers and contain a much lower percentage of hydrous iron oxide, as a rule not more than 5 per cent. Yellow shales that are worked for paint are usually called ochers, but such usage is plainly not justified.
>
> *Red shales.*—Red shales have been employed in the manufacture of paint in many places in the State, but at present operations are being carried on in only three localities. The operations are not limited, however, by the distribution and amount of the shales but by the market for the product. Red shales occur in many of the geologic formations, but are especially well represented in the Martinsburg ("Hudson River"), Catskill, and Mauch Chunk of the Paleozoic era and the Brunswick shale of the Triassic.
>
> The red coloring matter of these shales consists of ferric oxide, which forms a coating about the individual grains and was no doubt present when the shales were deposited. In some places the iron content has been changed somewhat since deposition by the precipitation of more iron oxide; in other places there has been subsequent leaching by which some of the iron has been removed. However, as shales are relatively impervious to water, they are less apt to undergo subsequent changes in composition than more pervious rocks.

DISTILLED SHALE.

A small quantity of carbonaceous shale is usually distilled in the United States each year. The resulting materials are a black residue and a dark oil, both used in the manufacture of paint. During 1911 the companies usually engaged in this work reported no production.

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[1] Bull. U. S. Geol. Survey No. 470, 1911, pp. 485-496.

WHITING.

Whiting was produced in two States in 1911, Kentucky and Missouri. Since only two companies reported to the Survey, the statistics of production can not be given. It may be stated, however, that the output of Missouri was greater than in 1910, while California, which has been a producer in the past, reported no production from domestic raw material in 1911.

Whiting or calcium carbonate ($CaCO_3$) is prepared by grinding various forms of soft and hard white limestone and calcite, the forms occurring in nature. The natural form has a higher specific gravity (2.74) than the form prepared artificially by precipitation (2.5), which is much finer and more even grained. Whiting is used largely in the manufacture of putty, in distemper work, and in small quantities in ready-mixed paints.

In a personal letter a deposit of calcspar, from which whiting is made, is described as occurring near Harrodsburg, Ky. The deposit is located on the south side of Kentucky River about 8 miles from the town of Harrodsburg, in Mercer County, and about 10 miles west of Highbridge, the point where the Queen & Crescent Railway crosses Kentucky River. The product is transported on barges to Highbridge or Madison, Ind., for shipment.

The product is finely ground, and is then packed in bags of 100 pounds each or barrels containing 500 pounds and is sold chiefly to paint manufacturers. Glass manufacturers are also reported to be using the material, and it is thought that it will find application in the rubber trade.

It is reported that the deposit may be traced back nearly a mile from the river cliff. It has been exploited at the bottom of the cliff just above high-water mark, and work has been carried in on it 75 feet. The deposit appears to be in the form of a vein varying from 3 to 9 feet in width; where now worked it is 6 feet wide. The walls are of limestone. Dynamite is used for blasting, and though the material comes out practically free from impurities, it is washed before grinding to give it a better color. The grinding is accomplished in a Raymond mill. The four analyses of the material furnished to the Survey show it to average 97.79 per cent calcium carbonate and 1.70 magnesium carbonate, with small quantities of moisture, silica, alumina, and iron oxide.

PIGMENTS MADE DIRECTLY FROM ORES.

PIGMENTS AND ORES.

The pigments here discussed are zinc oxide, leaded zinc oxide, zinc-lead, sublimed white lead, and sublimed blue lead.

The three white pigments having zinc for a base, either wholly or in part, are zinc oxide, zinc-lead oxide, of which there was none produced in 1911, and leaded zinc oxide. In the United States these pigments are usually made directly from ore. In addition to the two first named, which are made more particularly from what are regarded essentially as zinc ores, and the last mentioned, produced from mixed lead and zinc ores, there are two lead pigments produced directly from ore—sublimed white lead and sublimed blue lead. The ores used in making these pigments are the franklinite ores of New Jersey in the eastern part of the United States, and the zinc and lead ores of the

Mississippi Valley and of certain of the Western States. The zinc oxide made from the Austinville, Va., ore is used in making spelter and does not enter the paint trade.

In the upper Mississippi Valley lead and zinc region the zinc carbonate ore, smithsonite, locally known as "drybone," has been used almost altogether for pigment manufacture by the Mineral Point Zinc Co., but the sulphide ores of lead and zinc have also been used. In the Joplin region of Missouri, Kansas, and Oklahoma, the mixed silicate and carbonate ores of zinc have been used for zinc pigment manufacture, and galena has been used for the lead pigments. Zinc carbonate ore from New Mexico and mixed sulphide ores of lead and zinc from that and various other Western States have been extensively used in making zinc and zinc-lead pigments. Zinc carbonate ores imported from Mexico have also been used in the manufacture of zinc pigments. During 1911 zinc oxide and leaded zinc made directly from ores were reported from New Jersey, Pennsylvania, Wisconsin, and Kansas, and sublimed lead pigments were made in Missouri.

PRODUCTION.

In order to conceal individual returns, the statistics of production of zinc oxide, leaded zinc, sublimed white lead, and sublimed blue lead have to be combined for 1911. The total quantity of material produced amounted to 80,611 short tons, valued at $7,343,762. As compared with the production of 1910 this was an increase of 5,449 tons, or 7.2 per cent, in quantity, and of $490,958, or 7.2 per cent, in value.

The following table gives the production and value of pigments made directly from ores during the last four years:

Production of pigments made directly from ores, 1908–1911, in short tons.

Pigment.	1908		1909		1910		1911	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Sublimed blue lead	1,311	$121,923	981	$101,043	16,681	$1,613,859	80,611	$7,343,762
Sublimed white lead	9,100	973,700	9,915	1,070,820				
Leaded zinc oxide	[a] 8,430	778,200	[a] 7,655	634,714				
Zinc oxide	[b] 56,292	5,072,460	68,974	6,156,755	58,481	5,238,945		
Total	75,133	6,946,283	87,525	7,963,332	75,162	6,852,804	80,611	7,343,762

[a] Includes zinc lead.

[b] Exclusive of 945 tons from foreign ores.

IMPORTS OF ZINC OXIDE.

The following table gives the imports of zinc oxide into the United States during the last five years:

Imports for consumption of zinc oxide, 1907–1911, in pounds.

Year.	Dry.		In oil.		Total.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
1907	5,311,318	$323,551	362,814	$33,679	5,674,132	$357,230
1908	4,635,101	262,876	210,166	16,798	4,845,267	279,674
1909	6,119,328	342,999	535,024	54,085	6,654,352	397,084
1910	6,137,362	365,701	393,248	30,874	6,530,610	396,573
1911	5,012,308	316,972	548,708	40,494	5,561,016	357,466

ZINC OXIDE.

Zinc oxide is the most important of the zinc pigments. It is represented by the symbol ZnO and is a white powder consisting, when chemically pure, of 80.34 per cent zinc and 19.66 per cent oxygen. On account of its stability, whiteness, opaque nature, and slight tendency to chalk, it is invaluable as a pigment for use as a constituent in a combination formula. Its extreme hardness renders it less resistant to temperature changes when used alone. Zinc oxide resolves itself to a clear solution in all mineral acids. When examined under the microscope, the fineness and structure of the particles composing this pigment are clearly evident. Zinc oxide is manufactured by two processes, one known as the American and the other as the French process In the American process the prepared zinc ores are mixed with finely powdered hard coal and burned in closed furnaces over grates. The zinc is reduced to the metallic condition, volatilized, and burned. The product, zinc oxide, after being cooled by passing through a series of cooling flues, is collected in cloth bags which retain the white substance and permit the fumes to pass through and escape. When made in this manner the product may contain a very small quantity of lead sulphate, zinc sulphate, some iron oxide, and other impurities, provided they existed in the ores. In the French process the metallic zinc is violatilized and burned in a current of air and the zinc oxide produced is collected in closed chambers. It may be further purified to improve its color.

The ores from which zinc oxide is made are the franklinite ore of New Jersey, the sulphide (sphalerite) ores of the Mississippi Valley, and the sulphide, carbonate, and silicate ores of Colorado and New Mexico. The plants which produced zinc oxide in 1911 were the New Jersey Zinc Co. with plant located at Newark, N. J.; the New Jersey Zinc Co., of Pennsylvania, with plants located at Palmerton, South Bethlehem, and Freemansburg, Pa.; and the Mineral Point Zinc Co., located at Mineral Point, Wis. The Ozark Smelting & Mining Co., located at Coffeyville, Kans., and Joplin, Mo., reported sales of leaded zinc oxide, but no zinc oxide in 1911.

ZINC-LEAD AND LEADED ZINC OXIDE.

Zinc-lead is an extremely fine white pigment consisting of about equal parts of zinc oxide and lead sulphate. It is prepared from mixed lead and zinc ores and may contain as impurities small quantities of lead oxide, lead carbonate, and zinc sulphate. The present standard requires that zinc sulphate be present in quantities less than 1 per cent.[1] The pigment has a specific gravity of 4.4.

None of this pigment was produced in the United States during 1911, according to reports received by the Survey.

Leaded zinc oxides are pigments that resemble zinc-lead, but contain less lead sulphate. They are made with definite percentages of lead sulphate, usually ranging from 6 to 20 per cent, according to the purpose for which they are to be used. These oxides are produced from western ores that carry a certain proportion of lead sulphide. In fineness they are similar to zinc oxide, and in whiteness they stand between zinc oxide and zinc-lead.

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[1] Hall, C. H., The chemistry of paints and paint vehicles, 1906, p. 35.

SUBLIMED WHITE LEAD AND SUBLIMED BLUE LEAD.

Sublimed white lead is made directly from the lead sulphide ore galena. It is manufactured from ore produced in the Joplin, Mo. district or from any other soft (nonargentiferous) lead ore by a process similar in principle to that employed for making zinc oxide and zinc lead. Briefly summarized, the method of manufacture is as follows: Lead ore (galena), after having been cleaned at the mine by crushing, washing, and jigging, is ground to a powder and charged with carbon into a furnace over an open coke fire. The charge is volatilized and in the presence of air the lead sulphide is oxidized to a basic lead sulphate, while some free sulphur dioxide is formed. The basic lead sulphate is thought to be composed of two molecules of lead sulphate ($PbSO_4$) linked to one of lead oxide (PbO). This product, volatile while hot, is cooled by being drawn by suction through a long series of cooling pipes, or goosenecks, and some settling chambers, and then is collected in bags of the type used for collecting zinc oxide. The aim is to produce a pigment containing 75 per cent of lead sulphate, 20 per cent of lead oxide, and 5 per cent of zinc oxide. Notable properties of this pigment are its great fineness, the uniform size of its particles, and its relative chemical stability or inertness in the presence of coal gas, sulphur fumes, and other noxious gases that quickly darken some paints. It has a snow-white color and is very opaque, but since it is so extremely fine and of amorphous texture it requires blending with coarser pigments to give it "tooth"—that is, to prevent it from brushing out too thin.

Sublimed white lead finds use not only in mixed paints, but in putty and in the manufacture of rubber.

In the sublimation of galena a peculiar bluish-gray compound of lead is formed as a by-product, which is known commercially as "sublimed blue lead." In the furnace it is known as "fume." Analyses have shown the presence in it of about 2 per cent carbon, 4.5 to 5 per cent lead sulphide, 1 to 2.5 per cent zinc oxide, 0.36 to 1.44 per cent lead sulphite, 50 to 53 per cent lead sulphate, and 37.5 to 41.3 per cent lead oxide.

Sublimed blue lead, besides being used in paint manufacture, is used in the rubber industry.

CHEMICALLY MANUFACTURED PIGMENTS.

PRODUCTION.

The chemically manufactured pigments treated in this report include basic carbonate white lead, both dry and in oil, red lead, litharge, and orange mineral among the lead pigments, and lithopone and Venetian red. The last two pigments contain no lead but are chemically precipitated pigments, the process of whose manufacture will be given later.

Though the quantity and value of these pigments produced in 1911 was very great, amounting to 200,747 short tons, valued at $23,980,244, there was a decrease compared with 1910 which amounted to 6,249 tons in quantity and to $703,479 in value. The following table shows the production and value of chemically prepared pigments during the last four years:

Production of chemically manufactured pigments, 1908–1911, in short tons.

Pigment.	1908		1909		1910		1911	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Basic carbonate white lead:								
In oil	101,109	$12,552,771	115,259	$14,736,360	111,573	$15,027,993	106,778	$14,699,339
Dry	31,479	3,338,830	32,840	3,468,722	32,237	3,378,622	25,834	2,693,902
Red lead	16,720	2,065,202	[a]19,103	2,335,799	[a]19,801	2,448,684	[a]19,540	2,345,320
Litharge	15,542	1,887,506	20,690	2,363,002	23,742	2,686,159	25,190	2,773,196
Orange mineral	397	65,498	590	98,723	676	111,773	766	119,370
Lithopone	8,292	639,483	14,847	1,105,281	12,655	916,512	16,866	1,243,108
Venetian red	8,825	159,650	8,358	145,733	6,312	113,980	5,773	106,009
Total	182,364	20,708,940	211,687	24,253,620	206,996	24,683,723	200,747	23,980,244

[a] Includes a small quantity of orange mineral.

IMPORTS.

In the following table are given the quantity and value of the imports for the last five years of corroded white lead, red lead, litharge, orange mineral, and venetian red. The total value of these imports in 1911 was $138,564, or only a fraction of 1 per cent of the domestic production.

Basic carbonate white lead, red lead, litharge, orange mineral, and venetian red imported, 1907–1911, in pounds.

Year.	Corroded white lead.		Red lead.		Litharge.		Orange mineral.		Venetian red.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
1907	584,310	$37,482	679,171	$35,959	90,475	$4,386	615,015	$37,793	4,738,148	$37,869
1908	540,311	30,452	645,073	28,155	96,184	3,327	485,407	26,645	3,113,858	25,745
1909	694,599	39,963	760,179	30,428	90,655	3,740	496,231	27,562	3,999,560	28,864
1910	686,052	38,917	822,289	32,750	48,693	2,252	600,461	32,199	2,490,138	21,591
1911	741,071	46,213	1,063,533	42,471	24,662	1,196	504,734	28,515	2,194,823	20,169

BASIC CARBONATE WHITE LEAD.

Production.—The production of basic carbonate (corroded) white lead in 1911 as reported to the Survey was 132,612 short tons, valued at $17,393,241. Of this total, 106,778 short tons, valued at $14,699,339, were reported sold in oil, and 25,834 short tons, valued at $2,693,902, were reported sold dry. The sales for 1911 represented a net decrease from those for 1910 of 11,198 short tons in quantity and of $1,013,374 in value.

The average price per ton of basic carbonate white lead ground in oil was $137.66 in 1911, as compared with $134.69 in 1910, an increase of $2.97 per ton; and the average price per ton of dry white lead was $104.28 in 1911, as compared with $104.81 in 1910, a decrease of 53 cents per ton.

METHODS OF MAKING BASIC CARBONATE WHITE LEAD.

Dutch process.—This pigment [1] is made by stacking clay pots which contain dilute acetic acid and lead buckles in tiers and covering them with tan bark. Fermentation of the tan bark with subsequent formation of carbon dioxide acting on the acetate of lead formed within the pots produces basic carbonate of lead. After complete corrosion, the white lead is ground, floated, and dried. Basic carbonate of lead has a specific gravity of 6.8 and contains about 85 per cent lead oxide and 15 per cent of carbon dioxide and water. Various sized particles, both large and small, resulting from the corrosion process are present. Its opaque nature and excellent body render it extremely valuable as a pigment. Its life and wearing properties are considered by many paint manufacturers to be increased when mixed with zinc oxide and other pigments. Checking and chalking progress rapidly when the pigment is used alone.

Quick process.—The quick-process white lead is produced by the action on atomized metallic lead, contained within large revolving wooden cylinders, of dilute acetic acid and carbon dioxide.

Mild process.—Briefly, the mild process of manufacturing white lead consists of first melting the pig lead and converting it into the finest kind of lead powder, then mixing thoroughly with air and water. The lead takes up oxygen from the air and water, thus forming a basic hydroxide of lead. Carbon dioxide gas is next pumped slowly through the cylinders which contain the basic hydroxide of lead. The result is basic carbonate of lead—the dry white lead of commerce.

The process is called "mild" because it is the mildest process possible for the manufacture of white lead. The method does not require the use of acids, alkalies, or other chemicals, every trace of which should be removed from the finished product by expensive purifying processes.

RED LEAD.

Production.—The production of red lead fell from 19,801 short tons, valued at $2,448,684, in 1910, to 19,540 short tons, valued at $2,345,320, in 1911, a decrease of 261 short tons in quantity and of $103,364 in value. The average price per ton declined from $123.66 in 1910 to $120.03 in 1911, a decrease of $3.63 per ton.

By the continued oxidation of litharge [2] in reverberatory furnaces, red lead is produced as a brilliant red pigment. It has found wide application as an inhibitive pigment for the protection of iron and steel. In many cases the admixture of red lead with other pigments is of great value. The pigment particles appear to be of many sizes, showing a slight tendency to form a compact mass.

LITHARGE.

Production.—The production of litharge in 1911 as reported to the Survey was 25,190 short tons, valued at $2,773,196, as compared with 23,742 short tons, valued at $2,686,159, in 1910, an increase in quantity of 1,448 tons and in value of $87,037. The average price per ton was $110.09 in 1911 as compared with $113.14 in 1910.

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[1] Bull. Sci. Sec. Paint Mfrs. Assoc. U. S. No. 29, 1910, pp. 5-6.
[2] Idem, p. 24.

Litharge, or lead monoxide, is made directly by rapid oxidation o pig lead or by the oxidation of molten lead, or indirectly in the metallurgy of silver, and also from acetate of lead. Litharge is a buff colored powder. It is used in paints, in glazes, in storage batteries and for assaying.

ORANGE MINERAL.

Production.—The production of orange mineral as reported to th Survey was 766 short tons valued at $119,370 in 1911, as compare with 676 short tons valued at $111,773 in 1910. The apparent average price per ton was $155.84 in 1911, as compared with $165.34 i 1910.

Orange mineral is a form of red lead and is one of the higher oxide of lead. It is prepared by calcining a more or less basic carbonate o lead. It is valued according to the depth and color of its bright orang shade.

LITHOPONE.

Production.—The production of lithopone in 1911 was reported a 16,866 short tons, valued at $1,243,108, as compared with 12,65 short tons, valued at $916,512, in 1910, an increase in quantity o 4,211 tons and in value of $326,596. The apparent price per ton i 1911 was $73.70, as compared with $72.42 in 1910.

Lithopone,[1] a very white pigment, is precipitated by the doubl decomposition of zinc sulphate and barium sulphide, thereby forming an intimate mixture of zinc sulphide and barium sulphate. Th peculiar property which it possesses, of darkening under the actini rays of the sun, makes it essential that it be combined with othe more stable pigments to prolong its life when exposed to weather Lithopone contains approximately 70 per cent barium sulphate, 2 to 28 per cent zinc sulphide, and as high as 5 per cent of zinc oxide Its specific gravity is about 4.25. It is excellently suited for interio use in the manufacture of enamels and wall finishes. When properly mixed with other pagments, such as zinc oxide and calcium carbonate, fair results are obtained as a pigment for outside work. Lea pigments are never used with lithopone, as lead sulphide results giving a black appearance. The characteristic flocculent, noncrystalline appearance is plainly evident when examined under th microscope.

VENETIAN RED.

Production.—The production of Venetian red in 1911, as reported t the Survey, was 5,773 short tons, valued at $106,009, compare with 6,312 short tons, valued at $113,980, in 1910, a decrease i quantity of 539 tons and in value of $7,971. The apparent averag price per ton was $18.36 in 1911 as compared with $18.06 in 1910.

Venetian red is made in different ways, such as by grinding re iron oxide with gypsum, or by roasting ferrous sulphate with lime an grinding the residue—in either case the red is a mixture of iron oxid and calcium sulphate—or by grinding red iron oxide with calcium carbonate, or by calcining pyrite and ferrous sulphate with terra alba, and in sundry other ways.

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[1] Bull. Sci. Sec. Paint Mfrs. Assoc. U. S. No. 29, 1910, p. 10.

PAINT TESTS.

In this chapter in previous years brief notices and descriptions have been given of the paint tests of the scientific section of the Paint Manufacturers' Association of the United States, of the work of the Institute of Industrial Research, and of the publications regarding the tests in the Proceedings of the American Society for Testing Materials. The most recent publication on the results of these tests known to the writer is contained in volume 11 of the proceedings just referred to and is cited in the bibliography at the end of this chapter. The bibliography contains also references to works now in press as a result of examinations made in 1912 on the test fences at Atlantic City, N. J., at Nashville, Tenn., and at Pittsburgh, Pa., and to investigations recently carried out by H. A. Gardner at the Institute of Industrial Research, under the auspices of the scientific section of the Paint Manufacturers' Association.

In the report of committee "D-1" (on preservative coatings for structural materials) of the American Society for Testing Materials many interesting facts are recorded regarding results of paint tests made prior to the meeting held at Atlantic City June 27 to July 1, 1911. The work that had been accomplished during the preceding year was presented by the chairmen of the different subcommittees, and original papers were read at the meeting. See bibliography.

Subcommittee "B" reported on the condition of the Pennsylvania Railroad bridge at Havre de Grace, Md. The paint on the bridge was examined for (a) chalking, (b) checking, cracking, alligatoring, etc., and (c) general surface conditions. Five ratings were given as follows: Excellent, 10 to 8; good, 8 to 6; fair, 6 to 4; poor, 4 to 2; failure, 2 to 0.

Nineteen paints were examined, the compositions of which are given in volume 8 of the Proceedings. With the exception of six paints noted in the report—

> All paints are affording excellent protection on the bridge proper. It was noted that generally on the horizontal struts and laterals and their connections, affording easier accumulation of moisture, most of the paints show more or less deterioration. This only emphasizes the necessity for special care in painting structures. The light latticing of the main riveted members shows this tendency more or less in the majority of cases, most markedly on the upstream side of the structure.

Subcommittee "C" reported on paint vehicles. A quantity of 17 different oils was selected for these tests.

> An examination of the results obtained * * * showed generally that the greatest increase in weight occurred during the period in which the oil dried to a firm film. This occurred in most cases within 48 hours. After this period a slight increase in weight was often noticed and then a more or less steady decline, varying with the oil examined. Had the oil tests been continued for a greater length of time a much greater loss might have been observed.

Subcommittee "D" reported on the Atlantic City steel paint tests. Ratings were given each panel according to the amount of rust apparent on the painted surfaces of the panels, as well as to the degree of checking, chalking, scaling, cracking, peeling, loss of color, and other signs of paint failure shown. Two tables are given in the report of this subcommittee showing (1) the rating accorded by each inspector[1] to each panel, as well as an average for each panel, and (2) the rating of those panels which were considered by the subcommittee as meriting from 8 to 10 and as having given the bes service. For the details of these tests the reader is referred to th report of committee "A-5." (See bibliography.)

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[1] The number of inspectors was four.

Subcommittee "E" reported on linseed oil, and subcommittee "F on the definition of terms used in paint specifications.

Subcommittee "J" on the testing of white paints has developed the details of comprehensive exposure test of white pigments. Some 120 pigment formulas hav been designed from 13 single pigments in primary, binary, ternary, and quaternar combinations with a standard oil and drier, so as to show, if possible, the effect of th progressive increase in these pigments. The plan includes the details of a method t determine and obtain a uniform consistency of the paints and a design for the panel and fence for exposing them.

The pigments and oil for this test have been donated by paint manufacturers. Th grinding and mixing of the paints and the preparation of the drier has been undertake by Prof. Allen Rogers, of Pratt Institute, of Brooklyn. The Pennsylvania Railroa Co. will prepare the panels and the Baltimore & Ohio Railroad Co. will apply th paints. It is expected that the Departments of Agriculture and of Commerce an Labor will provide for the exposure of these panels at the experimental farm nea Arlington, Va. It is believed that the details of the test have been so determined an specified that the final result will add materially to the general knowledge on thi problem.

It was decided in conducting these tests to limit them strictly to white paints, no to use any tints. The paints are to be applied on both sides of yellow poplar panel 8 by 1 by 36 inches. Three of these single pieces are to be clamped together, formin a temporary surface 24 by 36 inches for the application of the paint. The paint is t be applied at a definite spreading rate; three coats, with at least seven days' tim between coats for drying. Two sets of these panels, each consisting of three piece painted on both sides, are to be used for each test. These panels are to be exposed i a fence or rack to be constructed as follows: Posts of locust or red cedar, 10 feet 10 inches long by approximately 6 inches in diameter, planted in rough concrete 2½ fee deep, 10 feet 6 inches in the clear between the posts. are to be connected by three line of 2 by 4 inch yellow-pine stringers. The top stringers are to be spiked to the top the posts; the middle and bottom stringers are to be notched in and spiked with clearance of 36½ inches. Two strips of 1 inch quarter-round molding are to be fastene with brass screws to the upper surface of the bottom stringers, to the upper and lowe surface of the middle stringers, and to the lower surface of the top stringers, with clearance of 1 inch between parallel lines of molding. The whole frame is to b painted with three coats of red oxide of iron ground in linseed oil. The panels afte having been painted and dried under cover are to be placed in the rack by removin one of the strips of molding, inserting the panels, and replacing the molding strip This fence is to be located so as to run north and south.

The mixtures of pigments are designed on the volume basis—that is, the mixtures. which are directly comparable, contain the same relative volumes of different pigments. For purposes of mixing, however, it is practically necessary to mix th pigments by weight; therefore in the accompanying list of formulas the proportion by weight as well as by volume are given. The pigments are to be mixed with raw oil, to which is to be added a known quantity of lead and manganese as linonates sufficient oil is to be used to give a standard viscosity.

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Buskett, E. W., Manufacture of zinc pigments: Mines and Minerals, November, 1907, pp. 193–194.

Cushman, A. S., The preservation of iron and steel: U. S. Department of Agriculture, Office of Public Roads, Bull. No. 35, May 21, 1909.

Cushman, A. S., and Gardner, H. A., Corrosion and preservation of iron and steel, McGraw-Hill Book Co., New York, 1910, 375 pp.

Dudley, Stanton, Paints in architecture, 16 pp.

Evans, S. M., Sublimed white lead as a pigment: Drugs, Oils, and Paints, April, 1911, pp. 419–420.

Gardner, H. A., The effect of crystalline pigments on the protection of wood: Jour. Frank. Inst., August, 1910, pp. 117–123.

——— Paints for the prevention of corrosion of iron and steel: Drugs, Oils, and Paints, March, 1911, pp. 376–377.

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Gordon, W. F., Zinc oxide and zinc-lead pigment manufacture: Eng. and Min. Jour., vol. 83, No. 22, June 1, 1907, pp. 1033–1036.

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Lowe, Houston, Paints for steel structures. John Wiley & Sons, New York, 5th ed rev. 1909. 115 p.

Macnichol, Charles, Painting concrete and cement structures: Drugs, Oils, anc Paints, March, 1909, pp. 391–392.

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Sabin, A. H., Paints and pigments: West. Soc. Engrs. Jour., January, 1911, pp. 1–31

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——— The "scientific" preparation and application of paint: Bull. Laboratory National Lead Co., Brooklyn, N. Y., Jan. 15, 1910.

——— "Modern white leads:" Bull. Laboratory National Lead Co., Brooklyn, N. Y., Jan. 31, 1910.

——— Linseed oil substitutes: Bull. Laboratory National Lead Co., Brooklyn, N. Y., Dec. 31, 1910.

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White, G. D., Paints for concrete, their need and requirements: Drugs, Oils, and Paints, August, 1909, pp. 95–96.

——— Waterproofing and painting concrete superstructures: Drugs, Oils, and Paints, April, 1910, pp. 411–412.

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American Society for Testing Materials—Continued.

Proceedings, vol. 9, 1909. Report of committee "E" on preservative coatings for structural materials, pp. 139–213; report of committee "U" on the corrosion of iron and steel, pp. 295–307.

Proceedings, vol. 10, 1910. Report of committee "A–5" on the corrosion of iron and steel, pp. 73–78; report of joint subcommittee in charge of erection and painting of steel test panels at Atlantic City, pp. 79–86; joint discussion, pp. 87–91; report of committee "D–1" on preservative coatings for structural materials, pp. 102–104; report of joint subcommittee on inspection of Havre de Grace bridge, pp. 105–107; report of subcommittee on inspection of the wooden panels at Atlantic City, pp. 107–113; report of subcommittee on the influence of pigments on corrosion, p. 115.

Proceedings, vol. 11, 1911. Report of committee "D–1" on preservative coatings for structural materials, pp. 173–175; report of subcommittee "B" on inspection of Havre de Grace bridge, pp. 176–180; report of subcommittee "C" on paint vehicles, pp. 181–191; report of subcommittee "D" on Atlantic City steel paint tests, pp. 192–194; report of subcommittee "E" on linseed oil, pp. 195–222; report of subcommittee "F" on the definition of terms used in paint specifications, pp. 223–224; report of subcommittee "J" on the testing of white paints, pp. 225–231. The proceedings for 1911 also contain the following papers which will be of interest to the paint trade:

Chapman, C. M., The value of the sulphuric-acid corrosion test, pp. 609–614.

——— Further results of the Westinghouse, Church, Kerr & Co. paint tests, pp. 628–634.

Gardner, H. A., The practical testing of drying and semidrying paint oils, pp. 641–649.

Outerbridge, A. E., jr., A novel method of detecting mineral oil and resin in other oils, pp. 650–664.

Scientific section, Paint Manufacturers' Association of the United States, Philadelphia, Pa.:

Preliminary booklet.—Addresses on paint, delivered before the Michigan chapter, American Institute of Architects, 1907.

Special bulletin.—Scientifically prepared paints and laws governing their manufacture. By Henry A. Gardner.

Special bulletin.—Excluding and rust inhibiting properties of paint pigments for the protection of steel and iron. By Henry A. Gardner.

1. Tables of white pigments and vehicle, standard nomenclature.
2. Standard can sizes recommended to paint manufacturers.
3. First report on the test fences erected by the scientific section. (Out of print.
4. Methods for the analysis of the vehicle constituents of paint.
5. Tests upon the corrosion of iron to be conducted by the scientific section. (Out of print.)
6. First annual report of the scientific section.
7. Preliminary report on steel test fences.
8. Report of committee "E" on preservative coatings for iron and steel.
9. Recent technical developments in paint manufacture.
10. Protective coatings for conservation of structural material.
11. The corrosion of iron and steel. By Alfred Sang. (Out of print.) (See also Proc. Eng. Soc. Western Pennsylvania, vol. 24, No. 10, January, 1909.)
12. The function of oxygen in the corrosion of metals. By William H. Walker.
13. Protective coatings for steel and iron. By Robert S. Perry. (Out of print.)
14. Coatings for the conservation of structural material. (Out of print.)
15. Protective coatings for structural material. By Robert S. Perry.
16. Atlantic City test fence: Report on first annual inspection. By Robert S. Perry and Henry A. Gardner.
17. First annual report on wearing of paints applied to Pittsburgh test fence.
18. First annual report on Atlantic City steel test fence.
19. Laboratory study of panels on Atlantic City and Pittsburgh test fences. (Out of print.)
20. Concrete coatings. By Henry A. Gardner.
21. A brief talk on paints. By Henry A. Gardner. (Out of print.)
22. Annual report for 1909.

Preliminary bulletin (second edition). Physical characterists of a paint coating. By Robert S. Perry.

23. The theory of driers, etc.
24. Some iron oxides and their values.
25. Report on examination of North Dakota test fences.

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An exhibition of certain analogies governing the manufacture of concrete and paint. By Robert S. Perry.

26. Second annual report on wearing of paints applied to Atlantic City test fenc
27. Second annual report on Atlantic City steel test fence.
28. Second annual report on wearing of paints applied to Pittsburg test fence.
29. The properties and structure of certain paint pigments.
30. The Tennessee white paint tests.

Institute of Industrial Research, Washington, D. C.:

1. The preservation of the exterior of wooden buildings.

(Not numbered.) The sanitary value of wall paints.

Circular No. 1. Paints for cypress and their necessity. By Henry A. Gardner.

Circular No. 2. The effect of color upon the durability of paint. By Henry A Gardner.

The following papers on the inspection tests and research work conducted b H. A. Gardner [1] at the Institute of Industrial Research under the auspices the scientific section of the Paint Manufacturers' Association of the Unite States, are now in press:

1. Inspection of Washington vehicle test fence. This article, which is illustrate contains definite information regarding the durability of various paint oils.
2. Soya oil and its most efficient driers.
3. Report on Atlantic City test fence, 1912 inspection.
4. Report on Tennessee wooden test fence, 1912 inspection.
5. Report on Pittsburgh wooden test fence, 1912 inspection.

North Dakota Agricultural College:

Report on the service condition of paints, by representatives of National Lead C committee: Paint Bulletin No. 2, Agricultural Experiment Station of North Dakot Fargo, N. Dak., February, 1910.

National Lead Co.:

Thompson, G. W., An outline for the rational treatment of paint problem Laboratory Bull. dated Feb. 15, 1911, 17 pp.

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Bussel, R. C., The definition of paint: Cir. No. 2, Proc. Paint and Varnish Soc. Eng land, 59 pp.; Paint, Oil and Drug Review, vol. 53, No. 5, Jan. 31, 1912, pp. 16–1 vol. 53, No. 6, Feb. 7, 1912, pp. 16–17; vol. 53, No. 7, Feb. 14, 1912, pp. 16–17; vol. 5 No. 8, Feb. 21, 1912, pp. 14–15; vol. 53, No. 9, Feb. 28, 1912, pp. 14–30.

Cathcart, Robert, The protection and finishing of concrete surfaces: Cir. No. Proc. Paint and Varnish Soc. England.

Cowan, W. J., The optical and physical properties of pigments: Cir. No. 5, Proc. Pain and Varnish Soc. England: Paint, Oil and Drug Review, vol. 53, No. 18, May 1, 191 pp. 16–17, pp. 18–19; vol. 53, No. 9, May 8, 1912, pp. 16–18.

Friend, J. N., An introduction to the chemistry of paints, Longmans, Green & Co 204 pp. and diagrams. $1.20.

Gardner, H. A., The effect of pigments ground in linseed oil: Drugs, Oils, and Paint vol. 27, No. 4, September, 1911.

——— A hygienic consideration of wall coatings (a paper read before the Internation Association of Master House Painters and Decorators): Drugs, Oils, and Paints, vo 27, No. 11, April, 1912, pp. 437–438; Paint, Oil and Drug Review, vol. 53, No. 9, Fe 28, 1912, pp. 18–20.

——— What makes white lead chalk and how chalking may be prevented: Jou Franklin Inst., January, 1912.

——— Paint technology and tests, McGraw-Hill Book Co., New York, 1911, 26 pp. $3.

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[1] Mr. Gardner is now working on two researches—the hardening of paint as affected by various su stances, and the reactions of linseed oil with the more common pigments.

GARDNER, H. A., The practical testing of drying and semidrying paint oils: Proc. Am. Soc. Testing Materials, vol. 11, 1911, pp. 641–649.

——— Paints for the prevention of corrosion of iron and steel: Drugs, Oils, and Paints, vol. 26, No. 10, March, 1912, pp. 376–377.

——— Paint protection for structural steel: Eng. Record, vol. 64, No. 9, pp. 254–255.

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HECKEL, G. B., Zinc from ore to oxide: Drugs, Oils, and Paints, vol. 26, No. 10, pp. 377–379.

LOVIBOND, J. W., Color nomenclature: Cir. No. 4, Proc. Paint and Varnish Soc. England.

McINTOSH, J. G., The manufacture of Venetian red and other iron pigments: Paint, Oil, and Drug Review, vol. 52, No. 11, Sept. 13, 1911, pp. 17–19; vol. 52, No. 12, Sept. 30, 1911, pp. 17–19.

MARTIN, H. W., Chemistry of paints: Paint, Oil, and Drug Review, vol. 52, No. 19, Nov. 8, 1911, p. 14; and in succeeding numbers.

MILLER, HEDLEY, The white lead question: Cir. No. 1, Proc. Paint and Varnish Soc. England, 40 pp.; Paint, Oil, and Drug Review, vol. 53, No. 5, Jan. 31, 1912, pp. 24, 25, 26.

NELSON, P. W., Hygienic consideration of wall coatings (a reply to H. A. Gardner): Paint, Oil, and Drug Review, vol. 53, No. 12, Mar. 20, 1912, pp. 14, 15, 16.

NICHOLSON, F. W., Testing paint and varnish: Paint, Oil, and Drug Review, vol. 52, No. 9, Aug. 30, 1911, pp. 24, 25, 26; vol. 52, No. 10, Sept. 6, 1911, pp. 24–25.

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PERRY, R. S., Lithopone and its uses for wall finishes: Drugs, Oils, and Paints, vol. 27, No. 10, March, 1912, p. 390.

PETERS, J. M., White lead: Paint, Oil, and Drug Review, vol. 52, No. 9, Aug. 30, 1911, pp. 17–18.

SABIN, A. H., Some new points in paint technology: Drugs, Oils, and Paints, vol. 26, No. 12, May, 1911, pp. 465–468.

SCHAEFFER, J. H., The story of the test fences: Paint, Oil, and Drug Review, vol. 53, No. 9, Feb. 28, 1912, pp. 24, 25, 26.

SCOTT, W. G., White paints and painting materials, 493 pp.

SLADE, N. C., A new method of testing paint films and preservative coatings for iron and steel: Drugs, Oils, and Paints, vol. 27, No. 12, May, 1912, pp. 479–481 (to be continued).

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——— Materials for permanent painting, D. Van Nostrand & Co., New York, 1911, 208 pp. $2.

——— The paint and varnish industry of the United States: Jour. Ind. and Chem. Engineering, April, 1912, pp. 241–242.

VAN HOCK, C. P., The covering power of paint films: Paint, Oil, and Drug Review, vol. 53, No. 19, May 8, 1912, pp. 14–15.

WILLIAMS, HENRY, Cheaper paints for the Navy: Drugs, Oils, and Paints, vol. 27, Nos. 10 and 11, March and April, 1912 (reprinted from Jour. U. S. Naval Institute).

ASBESTOS.

By J. S. Diller.

PRODUCTION.

The production of asbestos in the United States in 1911 was the largest in its history. The production is rapidly increasing; but it is only a small part, less than 8 per cent, of the production of Canada, which supplies the bulk of asbestos for the factories of the United States.[1]

The total domestic production for 1911 was 7,604 short tons, valued at $119,935, an increase of 106 per cent in quantity and of 75 per cent in value over the production of 1910. There were four producing States, Georgia, Vermont, Virginia, and Wyoming. Georgia and Virginia produced the amphibole variety (anthophyllite) only; Vermont and Wyoming produced almost wholly the serpentine variety (chrysotile). Vermont ranked first in production and Georgia second.

The following table shows the quantity and value of asbestos produced in the United States annually since 1890:

Annual production of asbestos in the United States, 1890–1911.

Year.	Production.			Year.	Production.		
	Quantity (short tons).	Value.	Average price per ton.		Quantity (short tons).	Value.	Average price per ton.
1890	71	$4,560	$64.23	1901	747	$13,498	$18.07
1891	66	3,960	60.00	1902	1,005	16,200	16.12
1892	104	6,416	61.69	1903	887	16,760	18.90
1893	50	2,500	50.00	1904	1,480	25,740	17.39
1894	325	4,463	13.73	1905	3,109	42,975	13.82
1895	795	13,525	17.01	1906	1,695	28,565	16.85
1896	504	6,100	12.10	1907	653	11,899	18.22
1897	580	6,450	11.12	1908	936	19,624	20.97
1898	605	10,300	17.02	1909	3,085	62,603	20.29
1899	681	11,740	17.24	1910	3,693	68,357	18.51
1900	1,054	16,310	15.47	1911	7,604	119,935	15.77

The prices of grades Nos. 1 and 2, crude, declined in 1911 about 10 per cent. The use of asbestos paper also declined somewhat, and the price fell about 20 per cent; but the other grades held their values, apparently with an increasing demand.

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[1] The types, modes of occurrence, and important localities of asbestos in the United States are described in Bull. U. S. Geol. Survey No. 470, 1911, pp. 505–524.

The reserves for future production seem to be large, but are not sufficiently developed for definite statement.

The rapidly developing interest in the lower grades of asbestos is encouraging to the producers in American fields, where, except in the Grand Canyon of the Colorado, the highest grade of crude is lacking, although much of the rock in several fields is rich in mill fiber.

Students of asbestos and of the problems of its production are referred to the most complete published source of information, the treatise of Fritz Cirkel, entitled "Chrysotile asbestos, its occurrence, exploitation, milling, and uses," the second enlarged edition of which was published in 1910 by the Mines Branch, Department of Mines, Canada.

APPLICATIONS.

One of the most remarkable features of the asbestos industry in recent times is the growth of the demand for the lower grades, which at first were regarded simply as waste by-products in the recovery of the higher grades. Although, as has been stated, prices of the higher grades of fiber declined in 1910 and 1911, the lower grades are reported as not only holding their own, but as being in increasing demand. The largest and most rapidly growing commercial application of the lower grades of asbestos is in the building arts, concerning which Mr. F. W. Fitzpatrick, a consulting architect of large experience, writes as follows:[1]

> Asbestos has been a keen competitor of magnesia in the line of steam and other pipe coverings; it has been pressed and felted to serve as lining for roofs and other insulating purposes; it has been used as packing by steam fitters and plumbers. But it is only since we have learned to combine it with cement that it has really begun to develop, so to speak, as a major material, one of very great rather than only secondary importance. And I, for one, firmly believe that the thing is still in its infancy and has a really wonderful future before it.

Referring to the use of asbestos in correcting the acoustic defects of a number of reverberant audience rooms lined with hard polished wall plaster, Mr. Fitzpatrick says:

> We tore off that plastering and substituted one rich in asbestos fiber, made it almost an asbestos cloth with but sufficient plaster to clinch, and left it comparatively rough—an absorbent, nonreflecting surface that produced no echoes and that absolutely cured the evil. This same thing has been done many times, and, they say, with satisfactory results.
>
> Naturally, in plaster or in cement work, the more asbestos there is mixed in the longer will the composite material resist disintegration by fire and will it afford protection to whatever it covers.
>
> American manufacturers are now making a splendid roof shingle composed of cement and asbestos that, I firmly believe, will outlast any other roof covering. It improves with age. In fire, slate will pop and crack and go to pieces; lead will melt; tin and iron will buckle and warp all out of shape; and of course shingle is a prey to every spark. The asbestos will resist fire as long as the best tile roofing and is infinitely less costly.
>
> I made some experiments four or five years ago at one of the big plants in reinforcing asbestos sheathing, pulping the asbestos, mixing with the cement and while green pressing two thicknesses together with a reenforcement of woven wire between—virtually the same scheme as wired glass. It worked all right, and the manufacturers are making and placing large quantities of asbestos building lumber, plain and reinforced. They fashion the material into doors, into wall siding, partitions, awnings; they corrugate it and make it into

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[1] Letter of Jan. 30, 1912.

roofing and walls instead of corrugated iron. They can fashion it about as easily as a carpenter can wood, and it is made in sheets 42 by 96 inches and as thick as five-eighths of an inch. It will hold nails. And this "lumber" is a splendid thing for electrical work on account of its high insulating qualities. For a like reason it is much used in breweries and cold-storage warehouses. In nearly every city the law compels the use of asbestos curtains in theaters. Experiments are being made with it, molding it and fashioning it into ornamental shapes, such as cornices and exterior decorations, to be used instead of galvanized iron. Asbestos enters very largely into the manufacture of finished floor coverings in fireproof buildings.

Steel furniture is now much in vogue in first-class buildings; it will be but a little while before asbestos is used in combination with that metal and in many cases will supersede it.

I am not enthusiast enough to aver that we are entering into an asbestos age, but it does seem to me that we have too long been blind to the immense possibilities of this splendid material, and we certainly are entering upon an era of much extended use of asbestos, one of the most plastic and serviceable materials known in the building arts.

A striking new application of asbestos was made in September, 1911, in extinguishing a burning oil well in Louisiana, one of the largest ever known, from which 40,000 barrels of oil were escaping daily. The fire was put out by tunneling to the vertical discharge pipe and inserting in it a trap filled with balls of asbestos wicking.[1]

ASBESTOS DEPOSITS IN THE UNITED STATES.

ARIZONA.

In the Grand Canyon of the Colorado beneath Bass camp, at the middle one of the three known localities of asbestos in 60 miles of the great chasm, a small amount of development work was done, but no shipments were reported in 1911. The 1,500-pound sample of asbestos from this locality, sent by E. B. Pike, of New York, to Germany for test was reported as entirely satisfactory and of superior quality. Electrical engineers in search of asbestos free from magnetite have carefully tested this asbestos and report it as excellent. Its high grade in this regard is a consequence of its unique origin in limestone. The lineal extent of the deposit is great, about a mile or more in each locality, though its thickness is only a few feet. On the other hand, the proportion of the high-grade crude to mill stock is much larger than in any other asbestos deposit with which the writer is acquainted. If the water power of Shinumo Creek can be made available, it would apparently enable the operator to overcome all the difficulties of transportation from the bottom of the canyon.

GEORGIA.

The production from Georgia is of the mass-fiber type of amphibole asbestos (anthophyllite), and the output in 1911 increased nearly 60 per cent as compared with that of 1910. The fiber, being brittle, is of low grade as compared with chrysotile, but its market, domestic and foreign, is established, and production from the Georgia locality has advanced for some years, notwithstanding the 12 miles of haul to the railroad.

Its value for asbestos shingles is being tested, and if it proves well suited for that use the demand for it will increase. Only a few localities of this mass fiber are known in Georgia, where the open pits or quarries from which the material is obtained are limited to the portion of the rock softened by weathering; but as the weathering is deep in that region, further search is likely to discover large quantities of available mass fiber. Dikes of the same material are known as far north as Bedford County, Va.

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[1] Sci. Am., Sept. 16, 1911; Literary Digest, Oct. 21, 1911.

VERMONT.

Vermont is by far the largest producer of asbestos in the United States, and during 1911 the output was increased nearly 132 per cent in quantity and 99 per cent in value as compared with that of 1910 The asbestos is of the cross-fiber chrysotile type and comes from the mine of the Lowell Lumber & Asbestos Co. on the slope of Mount Belvidere, near Lowell, in the northern portion of the State, where the rocks of the Canadian asbestos belt cross the international boundary. An account of this deposit is given in the chapter on asbestos in Mineral Resources for 1910 and in Bulletin 470, and need not be repeated here. The quantity of milling rock available is large.

During the year 1911 the asbestos mill of the Lowell Lumber & Asbestos Co. was enlarged, and new engines and additional machinery were installed to enhance its capacity. Expansion continues, and it is hoped that in the near future, with an export trade already initiated, a tonnage of production will be reached that will secure convenient railroad transportation. With the increased production the grade of fiber has improved, and in 1911, for the first time, there was for this country a considerable production of No. 2 crude. With a large reserve in condition favorable for mining and with the increased capacity of the mining plant, the production of chrysotile asbestos in Vermont grows more and more encouraging.

WYOMING.

Smith Creek, 20 miles southeast of Casper, and Casper Mountain, 8 miles south of Casper, in the Laramie Mountains, are the principal asbestos centers in Wyoming, although chrysotile asbestos of promising quality has been reported within the last few years from several points in the Bighorn and Antelope Mountains.

During 1911 considerable development work was done, but the lack of transportation facilities, especially to the Casper Mountain locality, has limited progress. With the erection of a mill on Smith Creek and another on Casper Mountain, as mentioned in this report for 1910, a production during 1911 was to have been expected if asbestos production was the object in view. A small production has been reported by the International Asbestos Mills & Power Co. and the Northwestern Asbestos Mills Co., and the output was sold to the Wyoming Asbestos Co., of Denver, Colo.

OTHER STATES.

California.—Prospecting continues in California by the Morgan Asbestos Mining & Manufacturing Co. a few miles southeast of Dutch Flat, Placer County, and good samples of fiber have recently been sent in from that region. Some of the samples are clearly cross-fiber chrysotile, with some slip fiber; they come from a mass of serpentine. At this point a great north-south area of serpentine from 1 to 3 miles in width is well exposed by the canyon of the North Fork of American River, on the north slope of which a number of tunnels have been driven.

Idaho.—No production was reported in 1911 from Idaho.

Virginia.—The American Asbestos Co., once a considerable producer in Virginia, has been reorganized as the Virginia Asbestos Co., and made at Bedford City, Va., a small production of the amphibole variety to supply its own demands for manufacturing purposes.

IMPORTS.

Canada is by far the most important source of the asbestos used in the United States. Unmanufactured asbestos, including ground, is admitted free, but manufactured asbestos is dutiable at 25 to 40 per cent ad valorem.

The Canadian exports of asbestos during the 12 months ending December 31, 1911, are reported by the customs department of the Dominion[1] as 75,120 short tons, valued at $2,067,259. Of this quantity 62,551 short tons were shipped to the United States; that is, 83 per cent of all that was exported by Canada and 62 per cent of all that Canada produced.

The sources from which the imports of asbestos are obtained are reported by the Bureau of Statistics of the Department of Commerce and Labor for fiscal years only. The imports during the fiscal year ending June 30, 1911, amounted to 57,124 long tons, equivalent to 63,979 short tons, valued at $1,318,539, as shown, with the sources from which obtained, in the following table.[2] The general decline of imports from Europe was more than counterbalanced by the influx from Canada.

Imports of unmanufactured (including ground) asbestos into the United States for the fiscal years ending June 30, 1908, 1909, 1910, and 1911.

	1908	1909	1910		1911	
			Quantity (long tons).	Value.	Quantity (long tons).	Value.
Germany	$1,036	$11,031	43	$3,484	123	$12,616
Italy	982	56	6	1,307	1	177
Russia in Europe	....	9,774	92	20,121	50	10,928
United Kingdom	48,038	20,623	47	10,075	....	16
Total for Europe	50,056	41,484	188	34,987	174	23,737
Canada	1,065,744	979,906	47,322	1,087,098	56,950	1,294,802
Grand total	1,115,800	1,021,390	47,510	1,122,085	57,124	1,318,539

The total value[2] of the manufactured asbestos imported during the year ending June 30, 1911, was $293,651, of which that from Canada was valued at $525; from Austria-Hungary, at $62,290; from Germany, at $72,192; and from the United Kingdom, at $133,113.

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[1] Preliminary report of the mineral production of Canada during the calendar year 1911: Dept. of Mines, Canada.

[2] Ann. Rept. on Commerce and Navigation for 1911; Dept. Commerce and Labor.

The value of manufactured and unmanufactured asbestos imported into the United States during the calendar years 1907 to 1911 is shown in the following table:

Value of asbestos imported into the United States, 1907–1911.

Year.	Unmanufactured.	Manufactured.	Total.
1907	$1,104,109	$200,371	$1,316,379
1908	1,068,322	127,548	1,195.870
1909	993,254	240,381	1,233,635
1910	1,235,170	308,078	1,543,248
1911	1,413,541	290,098	1,703,639

FOREIGN PRODUCTION.

CANADA.

Canada is the only foreign country whose production of asbestos is of great importance to the United States. For many years Canada has produced by far the larger part of the world's supply of asbestos. In 1911 the sales amounted to 100,893 tons, an increase of 30 per cent over the sales of 1910. In this is not included the lowest grade, which is called asbetic and of which alone 26,021 tons were produced in 1911.

Sales of asbestos and asbestic in Canada for the calendar years 1895–1911, in short tons.[1]

Year.	Asbestos.		Asbestic.	
	Quantity.	Value.	Quantity.	Value.
1895	8,756	$368,175	....	....
1896	10,892	423,066	1,358	$6,790
1897	13,202	399,528	17,240	45,840
1898	16,124	475,131	7,661	16,066
1899	17,700	468,635	7,746	17,214
1900	21,621	729,886	7,520	18,545
1901	32,892	1,248,645	7,325	11,114
1902	30,219	1,126,688	10,197	21,631
1903	31,129	915,888	10,548	16.869
1904	35,611	1,213,502	12,854	12,850
1905	50,669	1,486,359	17,594	16,900
1906	60,761	2,036,428	21,424	23,715
1907	62,130	2,484,768	28,296	20,275
1908	66,548	2,555,361	24,225	17,974
1909	63,349	2,284,587	23,951	17,188
1910	77,508	2,555,974	24,707	17,629
1911	100,893	2,922,062	26,021	21,045

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[1] Obtained from the report of the director of mines on the mines and metallurgical industries of Canada for 1907–8, pp. 448, 936. The data for 1909, 1910, and 1911 were obtained from the general summary of the mineral production of Canada during the calendar year 1911.

Canadian production of asbestos and asbestic sales, stock on hand, and values for 1911.[1]

	Output (short tons).	Sales.			Stock on hand Dec. 31.	
		Short tons.	Value.	Value per ton.	Short tons.	Value.
Crude No. 1	1,468	1,301	$342,855	$263.45	1,256	$327,508
Crude No. 2	3,594	3,563	402,107	112.86	3,223	404,198
Mill stock No. 1	20,376	18,315	916,678	50.05	8,471	380,570
Mill stock No. 2	39,289	47,326	991,370	20.95	17,794	365,457
Mill stock No. 3	31,572	30,388	269,052	8.85	3,824	31,367
Total asbestos	96,299	100,893	2,922,062	28.96	34,568	1,509,100
Total asbestic		26,021	21,045	.81		

[1] Preliminary of mineral production for 1911.

In the absence of a uniform classification of asbestos of different grades the subdivisions given in this table have been adopted by the Canadian Bureau of Mines purely on a basis of valuation; crude No. 1 comprises material valued at $200 per ton and upward, and crude No. 2 material valued under $200 per ton; mill stock No. 1 includes stock valued at from $30 to $100 per ton; No. 2, from $15 to $30 per ton; and No. 3, under $15 per ton.

OTHER COUNTRIES.

Next to Canada Russia is the most important producer of asbestos, but little of the Russian asbestos reaches the United States directly. Some of it may be imported from Germany. Several of the South African colonies, as well as Italy, Corsica, and Australia, are small producers but contribute little to the American factories. All other foreign countries together export to the United States only 0.003 per cent of the quantity furnished by Canada.

Three asbestos mines employing 30 men each are reported by the American consul as being in operation 45 miles northeast of Antung, China, and shipping their output chiefly into northern Manchuria. Judged by the sample sent to the Bureau of Manufactures the asbestos from these mines is of the amphibole type and brittle, and hence of little value in this country.

ASPHALT.

By David T. Day.

INTRODUCTION.

Asphalt.—The increased production of asphaltic materials in 1911 has resulted mainly from the movement throughout the United States for better roads. There is a growing conviction that asphaltic surfaces and binders add materially to the efficiency of roads in comparison with other surfaces and binders.

The production of hard asphalt (uintaite or gilsonite, elaterite, etc.), mainly from Utah, increased from 29,832 short tons in 1910, valued at $372,900, to 35,846 short tons in 1911, valued at $531,614. As heretofore this output of hard asphalt followed the vicissitudes of the varnish trade. The conditions of occurrence of these deposits and all other known deposits in the United States have been described in great detail by George H. Eldridge in the Twenty-second Annual Report of the United States Geological Survey. Other publications by the United States Geological Survey on asphalt are listed at the end of this report.

The production of asphalt obtained as a residuum from petroleum in California, Texas, Illinois, and the Mid-Continent field increased still more rapidly—from 159,424 short tons in 1910 to 234,951 tons in 1911, the value increasing from $2,207,937 to $2,684,230.

Bituminous rock.—The production from deposits of bituminous rock showed a marked decrease, owing chiefly to the cost of transportation for material containing a relatively small quantity of asphalt. No new deposits of bituminous rock were exploited during the year.

Ozokerite.—There was renewed activity in 1911 in developing the ozokerite deposits near Colton and at Soldiers Summit, Utah. There was no production, but the development work carried on during the year will probably result in a considerable product in 1912.

The importation of ozokerite for consumption in 1911 amounted to 4,472,708 pounds, valued at $388,461.

PRODUCTION.

DOMESTIC PRODUCTION.

The following tables summarize the statistics of production in the United States for 1911 and furnish comparisons with preceding years. The general condition which these figures present is sufficiently favorable to effect, probably, within the current year, the development of additional sources of supply.

The production in 1911 was 360,004 short tons, valued at $3,828,751, as against 260,080 short tons, valued at $3,080,067, in 1910.

Production of asphalt and bituminous rock, 1882–1911, in short tons.

Year.	Quantity.	Value.	Year.	Quantity.	Value.
1882	3,000	$10,500	1897	75,945	$664,6
1883	3,000	10,500	1898	76,337	675,6
1884	3,000	10,500	1899	75,085	553,9
1885	3,000	10,500	1900	54,389	415,9
1886	3,500	14,000	1901	63,134	555,3
1887	4,000	16,000	1902	105,458	765,0
1888	50,450	187,500	1903	101,255	1,005,4
1889	51,735	171,537	1904	108,572	879,8
1890	40,841	190,416	1905	115,267	758,1
1891	45,054	242,264	1906	138,059	1,290,3
1892	87,680	445,375	1907	223,861	2,826,4
1893	47,779	372,232	1908	198,382	2,057,8
1894	60,570	353,400	1909	228,655	2,138,2
1895	68,163	348,281	1910	260,080	3,080,0
1896	80,503	577,563	1911	360,004	3,828,7

The changes in production in the different classes of asphalt ar detailed for several years in the table which follows:

Production of asphalt, 1908–1911, by varieties, in short tons.

Variety.	1908		1909		1910		1911	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Bituminous rock	37,371	$146,821	55,376	$205,756	64,554	$400,557	51,328	$169,21
Refined bitumen	11,536	136,780	10,953	112,184	5,018	85,931	29,305	317,72
Maltha	12,875	162,000	652	8,047	1,252	12,742	8,574	125,96
Wurtzilite (elaterite)	450	36,000	220	1,400			610	30,50
Gilsonite	18,533	61,824	28,669	218,186	29,832	372,900	30,236	486,11
Grahamite	2,286	20,340	3,894	32,737			5,000	15,00
Ozokerite and tabbyite	50	2,500	30	1,500				
Oil asphalt	115,281	1,491,616	128,861	1,558,463	159,424	2,207,937	234,951	2,684,23
Total	198,382	2,057,881	228,655	2,138,273	260,080	3,080,067	360,004	3,828,75

The following table shows the production of asphalt, by States an kinds, in 1910 and 1911:

Production of asphalt in 1910 and 1911, by varieties and by States, in short tons.

1910.

Variety.	California.		Utah.		Oklahoma.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Bituminous rock	37,547	$128,212	5,110	$153,398	11,959	$65,24
Refined bitumen	2,976	30,670	755	43,035		
Maltha	1,252	12,742				
Uintaite (gilsonite)			29,832	372,900		
Wurtzilite (elaterite) and tabbyite						
Grahamite						
Oil asphalt	101,711	1,167,112				
Total	143,486	1,338,736	35,697	569,333	11,959	65,24

Production of asphalt in 1910 and 1911, by varieties and by States, in short tons—Con.

1910—Continued.

Variety.	Kentucky.		Texas.		Total.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Bituminous rock	9,938	$53,703			64,554	$400,557
Refined bitumen	1,287	12,226			5,018	85,931
Maltha					1,252	12,742
Uintaite (gilsonite)					29,832	372,900
Wurtzilite (elaterite) and tabbyite						
Grahamite						
Oil asphalt			57,713	$1,040,825	159,424	2,207,937
Total	11,225	65,929	57,713	1,040,825	260,080	3,080,067

1911.

Variety.	California.		Utah.		Oklahoma.[a]	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Bituminous rock	27,507	$89,264			23,821	$79,955
Refined bitumen	15,589	179,646			916	10,076
Maltha	8,574	125,966				
Uintaite (gilsonite)			30,236	$486,114		
Wurtzilite (elaterite) and tabbyite			610	30,500		
Grahamite					5,000	15,000
Oil asphalt	139,275	1,709,545			52,650	315,900
Total	190,945	2,104,421	30,846	516,614	82,387	420,931

Variety.	Texas.		Total.	
	Quantity.	Value.	Quantity.	Value.
Bituminous rock			51,328	$169,219
Refined bitumen[b]	12,800	$128,000	29,305	317,722
Maltha			8,574	125,966
Uintaite (gilsonite)			30,236	486,114
Wurtzilite (elaterite) and tabbyite			610	30,500
Grahamite			5,000	15,000
Oil asphalt	43,026	658,785	234,951	2,684,230
Total	55,826	786,785	360,004	3,828,751

[a] Includes Illinois and Kentucky.

[b] Includes a small quantity of mastic in California and Oklahoma.

PRODUCTION IN PRINCIPAL COUNTRIES.

The following table shows the production of asphalt in the principal producing countries from 1902 to 1910, inclusive:

Production of asphalt and bituminous rock in the principal producing countries, 1902–1910, in short tons.

Year.	United States.		Trinidad.[a]		Germany.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
1902	105,458	$765,048	178,230	$828,347	97,415	$146,470
1903	101,255	1,005,446	204,880	943,302	96,401	198,940
1904	108,572	879,836	152,392	727,552	101,121	212,058
1905	115,267	758,153	114,845	626,293	113,513	235,620
1906	138,059	1,290,340	150,373	832,964	129,388	268,631
1907	223,861	2,826,489	171,271	832,274	139,567	264,494
1908	198,382	2,057,881	143,552	403,023	98,088	188,334
1909	228,655	2,138,273	159,416	459,446	85,446	176,897
1910	260,080	3,080,067				

[a] Includes small quantity of manjak, produced in Barbados.

Production of asphalt and bituminous rock in the principal producing countries, 1902–191 in short tons—Continued.

Year.	France.		Italy.		Spain.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
1902	284,719	$390,254	70,619	$151,829	6,946	$12,3
1903	267,859	353,535	98,865	240,497	6,918	12,2
1904	250,222	289,415	123,347	307,985	4,146	7,2
1905	211,043	325,340	117,929	298,097	7,135	14,7
1906	216,405	345,599	144,802	349,926	8,587	17,1
1907	195,136	330,065	178,127	442,014	9,057	16,0
1908	188,616	264,188	148,433	368,306	13,635	24,0
1909	186,298	269,161	123,361	305,159	5,822	10,2

Year.	Austria-Hungary.		Russia.		Venezuela.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
1902	4,047	$67,623	13,624	$116,935	11,872	(*a*)
1903	2,715	62,492	28,281	217,085	*b* 16,057	$286,11
1904	4,029	59,386	*c* 95	230,541	*b* 14,910	262,8
1905	8,257	854,197	23,659	201,965	*b* 33,803	258,5
1906	10,633	778,781	12,517	110,294	*b* 22,128	98,2
1907	11,335	727,892	14,116	101,705	*b* 37,637	167,9
1908	12,239	768,162	24,961	(*a*)	*b* 31,539	141,91
1909	11,179	663,246	(*a*)	(*a*)	*b* 37,292	180,0

a Not available. *b* Exports. *c* Ozokerite only; quantity of asphalt not available.

IMPORTS.

The following table shows the imports of asphalt, by calendar years from 1907 to 1911, inclusive:

Asphalt imported for consumption into the United States, 1907–1911, in short tons.

Year.	Crude.		Dried or advanced.		Bituminous limestone.		Total.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
1907	142,494	$502,811	13,535	$127,024	4,925	$15,629	160,954	*a* $648,56
1908	137,808	532,297	7,642	67,364	6,224	20,758	151,674	*a* 624,97
1909	128,109	511,631	10,087	94,146	6,409	18,440	144,605	*a* 633,20
1910	162,435	588,206	20,180	178,704	3,696	9,301	186,311	*a* 785,96
1911	149,715	572,198	18,269	184,954	7,304	23,468	165,288	789,23

a Imports for 1907 include $3,100 of manufactures; 1908, $4,560; 1909, $8,988; 1910, $9,752.

The following table shows the imports, by countries, of asphal into the United States for the fiscal years 1902 to 1911:

Asphalt imported into the United States during the fiscal years ending June 30, 1902 to 1911, by countries, in short tons.

CRUDE.

Imported from—	1902		1903		1904		1905		1906	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Europe:										
Austria-Hungary					2	$46			10	$108
Belgium	98	$830								
France							202	$706		
Germany	50	362	113	$739	222	2,595	25	285	328	2,983
Italy	20	757	39	1,006	10	389				
Netherlands	35	1,122						36		
Switzerland										
Turkey			541	7,676						
United Kingdom	92	1,135	112	1,304	12	135	65	739	121	2,076
North America:										
Canada		4			130	1,032			34	379
Mexico	41	629	117	1,229	45	489	7	571		
West Indies—										
British	99,592	329,819	128,026	353,284	105,748	326,391	85,968	378,669	48,842	184,951
Cuba	7,252	28,497	9,838	46,784	9,481	22,068	12,260	44,014	5,348	26,206
Danish										
South America:										
Colombia	1	15	3	106	23	1,456	23	672		
Venezuela	12,406	62,028	10,291	45,677	37,425	156,621	21,595	106,723	20,000	100,000
Asia:										
East Indies—										
British India					49	312				
Turkey	38	3,679	67	5,038	119	2,763	399	6,158	17	391
Oceania										
Total	119,625	428,877	149,147	462,843	153,266	514,297	120,544	538,573	74,700	317,094
DRIED OR ADVANCED.										
Europe:										
Austria-Hungary							10	$99		
France	17	$210	298	$1,462			100	1,277	167	$1,411
Germany	731	6,148	1,309	9,235	1,006	$8,085	347	3,157	946	9,090
Italy	9,430	28,033	13,750	60,278	1	15				
Netherlands										
Switzerland	1,182	11,554	442	3,735	414	3,815	1,327	12,986	655	5,595
Turkey	29	396	97	1,241						
United Kingdom	251	4,551	24	1,581	51	797	1	434	299	3,956
North America:										
Canada										
Mexico	14	195	504	1,145	337	1,734	348	3,461	422	2,529
West Indies—										
British	2,650	11,418	1,107	13,714	4,283	42,232	1,722	18,608	3,785	47,979
Cuba			60	1,434	13	162	36	515		
South America:										
Colombia										
Venezuela			6,154	29,197	12,769	60,396	8,281	42,850		
Oceania										
Total	14,304	62,505	23,745	123,022	18,874	117,236	12,172	83,387	6,274	70,560
BITUMINOUS LIMESTONE.										
Europe:										
Germany					300	$1,075			1,111	$4,139
Italy					3,200	11,177	7,863	$28,244		
Switzerland										
Total					3,500	12,252	7,863	28,244	1,111	4,139

Asphalt imported into the United States during the fiscal years ended June 30, 1902
1911, by countries, in short tons—Continued.

CRUDE.

Imported from—	1907		1908		1909		1910		1911	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Valu
Europe:										
Austria-Hungary										
Belgium							12	$369	364	$5,
France	11	$252			84	$1,120	1,648	7,917	119	1,
Germany	217	1,926	255	$2,418	1,210	11,054	2,294	18,587	2,091	17,
Italy	3,480	11,502	50	419	4,222	15,441	3,050	8,092	6,099	17,
Netherlands					59	666				
Switzerland					817	6,937	1,280	9,184	750	5,
Turkey										
United Kingdom	260	2,947	125	3,037	304	4,002	274	6,808	297	6,
North America:										
Canada	4	18			2	90			36	
Mexico		3			76	1,390	145	2,652	32	
West Indies—										
British	68,003	250,058	99,139	334,526	83,529	312,944	89,994	407,325	94,594	405,
Cuba	5,016	20,362	3,976	17,983	7,174	36,618	13,873	73,455	14,027	73,
Danish							200	800		
South America:										
Colombia	67	2,856	91	4,399	34	1,356	1	9	45	1,
Venezuela	33,921	169,278	37,822	202,031	30,528	214,049	33,503	173,363	34,104	170,
Asia:										
East Indies—British India										
Turkey	36	2,496	24	1,659			8	554		
Oceania				34	11	429	89	3,436	10	
Total	111,015	461,698	141,482	566,506	128,050	606,096	146,371	712,551	152,568	707,

DRIED OR ADVANCED.[a]

Europe:										
Austria-Hungary										
France	100	$839								
Germany	2,450	23,452	2,116	$18,554						
Italy	394	1,930	98	927						
Netherlands	99	1,134	196	2,268						
Switzerland	823	7,696	607	5,631						
Turkey										
United Kingdom	408	5,515	247	3,300						
North America:										
Canada			4	88						
Mexico	2,733	34,633								
West Indies—										
British	2,989	31,186	5,588	55,208						
Cuba										
South America:										
Colombia	22	140								
Venezuela										
Oceania			10	393						
Total	10,018	106,525	8,866	86,369						

BITUMINOUS LIMESTONE.[a]

Europe:										
Germany										
Italy	3,330	$10,677	3,401	$12,789						
Switzerland	67	992	98	676						
Total	3,397	11,669	3,499	13,465						

[a] Included in "Crude" after 1908.

EXPORTS.

During the year 1911 domestic unmanufactured asphalt and manufactures of asphalt to the value of $598,930 were exported from the United States,[1] as against exports valued at $702,520 in 1910.

EXPORTS FROM TRINIDAD.

The exports of asphalt from Trinidad from 1907 to 1911, inclusive, are shown in the following table:

Total exports of asphalt from Trinidad, 1907–1911, in short tons.

Year.[a]	To United States.			To Europe.			To other countries.			Grand total.
	Lake.	Land.	Total.	Lake.	Land.	Total.	Lake.	Land.	Total.	
1907	97,243	4,642	101,885	59,987	224	60,211		230	230	162,096
1908	92,212	5,886	98,098	51,183	1,276	52,459				150,557
1909	97,629	13,787	111,416	49,345	224	49,569				160 985
1910	109,198	9,274	118,472	65,778	150	65,928				184,400
1911	103,590	8,040	111,630	67,105		67,105	983		983	179,718

[a] Ending Jan. 31 of year succeeding.

SOURCES OF SUPPLY.

DOMESTIC LOCALITIES.

Utah.—Hard asphalt was produced only in Utah and Oklahoma and consisted chiefly of the easily soluble variety, gilsonite. A small quantity of elaterite also was produced in Utah. The product from the well-known localities in Uinta County, Utah, including the output of a new company which began to produce in 1911, sufficed for the market requirements without drawing on the deposits in Oklahoma to any considerable extent or upon the deposit of grahamite worked many years ago in Ritchie County, W. Va., where an effort was made in 1909 to reopen and work the deposit.

The natural soft asphalts in the United States have been almost entirely replaced in use by the residual asphalts obtained from asphaltic petroleum.

Toward the end of 1911 preparations were active for developing the soft asphalt known to underlie the great Salt Lake near its northern shore. Previous efforts to develop this deposit were made by drilling on the northern bank of the lake. Lately a well has been driven from a raft anchored at a point 1,500 feet from the shore; and a small flow of soft asphalt was developed at 210 feet.

Wyoming.—In the neighborhood of Lander, Wyo., active work was in progress for marketing the soft asphalt found a few years ago in drilling for oil. The property has been in litigation since the principal owner's death.

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[1] Figures cover period since July 1, 1911; included in "All other articles" prior to July 1, 1911.

Analysis of crude liquid asphalt from near Lander, Wyo.

[Dow & Smith, analysts.]

Consistency at 60° F., stiff liquid; water, 12 per cent.

Analysis of dried sample.

	Per cent.
Bitumen soluble in carbon disulphide	84.1
Organic insoluble in carbon disulphide	3.5
Mineral matter	12.4

Two refinings were made. In the one the material was refined down to the consistency of an asphalt cement having a penetration of 57; in the other the material was reduced to a refined asphalt having a consistency of 27 penetration. These materials are designated below respectively A and B:

	A.	B.
Material evaporated to consistency of penetration	57	27
Yield from liquid asphalt freed from water per cent	84.9	80.2

Analysis of refined asphalt B (27 penetration).

	Per cent.
Bitumen soluble in carbon disulphide	80.0
Organic insoluble in carbon disulphide	4.5
Mineral matter	15.5

An asphalt cement was made by fluxing 100 parts of refined asphalt B with 20 parts of a residuum from Atlantic Refining Co., making an asphalt cement of 48 penetration.

Examination of asphalt cement A and asphalt cement B from refined asphalt B.

	A.	B.
Penetration at 77° F	57	48
Ductility at 77° F centimeters	35	10
Loss on heating at 325° F. 5 hours per cent	1.1	0.8
Penetration after heating	33	33

New Mexico.—The occurrence of black peaty material in McKinley County, N. Mex., gave rise to statements that asphalt had been found, but analyses of the material made at the instance of Mr. Amado Chaves proved that it contains no asphalt.

FOREIGN LOCALITIES.

Trinidad and Bermudez.—The chief foreign sources of asphalt have shown little change during 1911. The importations into the United States from the Island of Trinidad are being replaced to a considerable extent by the soft asphalt of Bermudez, Venezuela, which has been exploited actively.

Mexico.—In Mexico attention has been diverted temporarily from exploitation of the large deposits of asphalt to the more alluring quest for petroleum, so that the asphalt industry has been limited to supplying the domestic trade in the City of Mexico and some other cities of that Republic with paving and roofing asphalt obtained as residuum from the oil refineries of Tampico and Minititlan.

Cuba.—In the report on the mineral reconnaissance of Cuba made in 1901 to the War Department by Hayes, Spencer, and Vaughan and in the subsequent report of H. C. Brown on Cuban mineral industries reference is made to the numerous localities, usually in the eastern half of the island, where asphalts of various grades are known to occur. It is also well known that Sr. Torrentegui, a citizen of Cardenas, mined hard asphalt at several points in Cardenas Harbor, especially in the shoal water next to the north end of Key Cupey. His various attempts to mine this asphalt on a large scale proved futile because of stones which quickly wrecked the caissons which he endeavored to drive into the asphalt. He therefore depended on such crude methods as breaking up the asphalt as he found it in the muddy bottom with a long drill or crowbar and then bringing it to the surface with grappling tongs.

This industry ceased with Sr. Torrentegui's death, but hard asphalt has also been mined at Menendez, on the northern seacoast east of Cardenas, and to a large extent at the Jatibonico mines, in the mountainous country north of the railroad station of the same name. The development there has been suspended on account of litigation. The character of the hard asphalt and its mode of occurrence is well shown near Placetas de Sur, where recent exploitation has developed several veins varying in width from about 2 to 8 feet and nearly vertical. The veins are in decomposed serpentine. One wall is usually very smooth and the other more irregular. The veins run at various angles to one another, no regularity being evident as in the gilsonite veins of Utah.

At the outcrops, this asphalt is usually very friable and like coke, but at depth it is, though friable, quite compact and of a glossy black, and it has a distinct odor of oil.

The glossy black material is easily soluble in benzol and spirits of turpentine, and resembles gilsonite in this respect. The cokelike material is much less readily soluble.

In many other places, liquid and semiliquid asphalt has been discovered, especially at Sabanilla, east of Cardenas, and near Minas, 20 miles northeast of the town of Camaguey. Here seepages are frequent over considerable areas, but no considerable supply has been proved. The material is found in all grades from a thick liquid to solid and even cokelike forms.

Japan.—Japan is credited with producing 4,600 short tons of Few's pitch in 1909, valued at $40 per ton.

SYNOPSIS OF FOREIGN OCCURRENCES OF ASPHALT.

In the following tabular form is presented a synopsis of the chief occurrences of asphalt in foreign countries, by kinds:

Synopsis of the chief occurrences of asphalt in foreign countries.

Country.	Kind.	Remarks.
Cuba:		
Pinar del Rio	Glance pitch Asphaltic sandstone	Asphalt has been reported in every Province. Formerly mined near Bahia Honda. More than a dozen openings, some large, between Habana and Mariel. All the present production comes from these deposits.
Habana	Soft asphalt	
Matanzas	Hard and soft	Hard asphalt was mined for years from the bottom of Cardenas Harbor by Sr. Torrentegui and sold for varnish. Soft asphalt was mined at the mouth of Rio de Palma. Much soft material is found on the Hamel properties, near Sabanilla de la Palma.

Synopsis of the chief occurrences of asphalt in foreign countries—Continued.

Country.	Kind.	Remarks.
Cuba—Continued.		
Santa Clara	Hard	At Placetas del Sur perpendicular veins of hard varnish pitch have been opened. Specimens of soft asphalt have been obtained in the same neighborhood.
Camaguey	do	On the western edge of the Province considerable deposits have been opened and mined and hauled on mule back to Caibarien, on the north coast. The material is pure varnish pitch.
	Soft	Near Minas, a station between Camaguey and Nuevitas, a pit 37 feet deep shows soft asphalt seeping into it. Hardened material is found near the surface in pieces in the soil.
Santiago de Cuba.	Hard	6 miles south of Puerto Padre; not developed.
Mexico	Hard and soft	In Vera Cruz and Tamaulipas asphalt seepages, usually soft, are very numerous at the contact of the limestones with eruptive masses. Occasionally the amount of asphalt is very great, especially near Tuxpam.
Trinidad	Soft; mixed with much clay and water.	This impure mixture of soft asphalt, water, and clay, having somewhat the nature of petroleum emulsions, has been the chief source of supply for asphalt paving in the United States. Its occurrence in the great Trinidad pitch lake and in near-by "land" deposits has been frequently described in these reports.
Venezuela (Bermudez).	Soft; purer than Trinidad.	Mined by hand labor and hauled in mine cars to river lighters and transferred again to steamers for export, chiefly to the United States. Production increasing.
Barbados	Glance pitch, used for varnish—called "manjak."	Manjak is a very pure, friable pitch, suitable for "Brunswick" varnish and other high-grade products. It occurs on the east side of the island in veins with a north-northeast strike and varying dip. Production not large.
Argentina	Soft	Occurs, in connection with heavy oils, near Comodoro Rivadiva. Not yet productive.
France	Bituminous limestone.	The limestones and schists, containing usually 7 to 14 per cent of asphalt, are found at Autun, in the Department of Saone-et-Loire; at Aumance, in Allier; and in Ain, Gard, Puy-du-Dome, and Haute-Savoie. The asphalt has been mined since 1838 and has been largely used in paving the streets of Paris. It has also been exported in large quantities.
Switzerland	do	In 1912 the 200-year jubilee will be celebrated of the discovery of asphaltic limestone. Worked at Val de Travers, Neuchatel.
Italy	do	In Sicily, at Ragusa, Syracuse, Mazzarelli, and Catania.
Germany	Asphaltic limestones and sandstones.	At Lobsann, Alsace. Operated in a primitive way for 75 years. Veins 3 to 30 feet thick.
Greece	Asphaltic limestone	Near Marathonopolis; 15 to 25 per cent of asphaltic oil.
Syria	Hard varnish pitch	Principal mine is at Hasbeya, near the headwaters of the Jordan; also around the Dead Sea, in Latakia Mountains, and in southern Palestine, near Beersheba.
Russia	Hard and asphaltic sandstones.	Near Syzran and Samara, and very commonly in the Caucasus; also on Tcheleken Island, in the Caspian Sea. Ozokerite is also found in the last place.
Turkey	Hard	Worked chiefly at Selenitza, in Albania; also occurs in many other localities, particularly near Nasarieh, Busreh Province.
Japan	do	In Echigo, associated with oil seepages.
Galicia	Ozokerite	Most of the ozokerite comes from Boryslaw, with smaller quantities from Dzwiniacz, Starunia, and Truskamiec. Described in Der Erdwachsbergbau in Boryslaw, by J. Muck (Julius Springer, Berlin, 1903). The ozokerite occurs partly in fairly pure masses, and also disseminated through the Miocene clays in which it is found. The masses are purified by melting. The clay containing ozokerite is heated in water until the melted wax rises to the surface.
Russia	do	Large quantities are reported on Tcheleken Island, in the Caspian Sea.

CLASSIFICATION OF ASPHALT ACCORDING TO USE.

The complex mixtures included under the head of asphalt should be divided at least into the commercial groups, which serve the purposes of the several industries to which asphalt contributes.

Since the origin of asphalt is most obscure and the nature of these indefinite mixtures is so poorly understood, little that is definite can be stated in regard to them.

Classification by D. Holde.—Not especially on account of originality, but rather for comprehensiveness of character and clearness of expression, the classification of bitumens by Prof. D. Holde is selected from many and is abstracted below from a leaflet distributed at the Vienna meeting of the International Petroleum Commission.

It is difficult to give sharp limits to the expression "bitumen." It is derived from "pix tumens" (swelling pitch) and embraces in a narrower sense only natural asphalt freed from its earthy impurities and soluble in carbon disulphide. This expression "bitumen" has later been extended in literature and in technology to include the substitutes for natural asphalt used for construction purposes, etc.—that is to say, the tar obtained by the distillation of petroleum and the residue similar to asphalt, such as petroleum pitch, coal tar, pitch, etc.—but not the insoluble residues rich in carbon and insoluble in benzol and carbon disulphide, for example, pitch from oil gas. In a still more extended sense there are also regarded as bitumens certain other materials found in nature, such as the gaseous, liquid, and solid hydrocarbons and saponifiable materials (natural gas, petroleum, ozokerite, and mountain wax), and finally, in the broadest sense, there are included as bitumens the materials used as substitutes for natural products and obtained by the distillation of coal, of fats, of peat, shales, etc., in general oils of very much less value. The designation "bitumen" is also in literature and in trade use given to substances as, for example, to the organic bitumens in bituminous schist, which yield hydrocarbon oils only after dry distillation or distillation with steam, but which before this do not contain any material soluble in benzol or carbon disulphide. In carrying out this point of view, one must also consider bituminous coal, which yields distillates, as a form of bitumen, although it does not contain bitumen in soluble form.

A still further extension of the expression "bitumen" to materials such as cellulose, which yield tar on distillation, does not seem advisable. The following table has been devised by the author in connection with the German Society for Testing Materials and partly with the aid of Prof. Marcusson:

Technical bitumens.

A. Formed in nature.

I. Saponifiable (principally wax fats):
    Sapropel wax.
    Algae wax.
    Lignite bitumen (raw crude mountain wax).
        These waxes, on account of geological considerations as to the origin of bitumens, are to be regarded as the earlier stage in the process of formation of the materials mentioned under the following heading.

II. Not saponifiable (principally hydrocarbons, also lignite and solid bitumens, oxidized and sulphureted hydrocarbons).
    Solid or sulphureted and oxidized hydrocarbons, natural asphalt, natural tar, etc., the first containing from 2 to 12 per cent sulphur.
        (a) Natural gas.
        (b) Petroleum, liquid and semisolid.
            Distillates, oils, petroleum benzine (boiling up to 150° C.).
            Illuminating oils, gas oils, lubricating oils, petroleum paraffin, liquid mineral oils, and semiliquid tar, harder petroleum tar, and petroleum coke.
        (c) Natural wax (ozokerite).
            By refining processes yields ceresin, or by distillation paraffin wax and oil.

B. Oils and tar obtained by destructive distillation.

I. Tar rich in paraffin.
    (a) Distillates:
        Benzine.
        Solar oil.
        Gas oil.
        Paraffin oil.
            Contains from 0.8 to 1.4 per cent of sulphur, paraffin wax coal tar (soft), coal tar (hard), and coal-tar coke.
    (b) Residues.
II. Shale tar.
    Yields by distillation products similar to coal tar.
    (a) Distillates:
        Oils and shale oil.
        Paraffin wax.
    (b) Residues.
III. Tar from bituminous coal.
    Contains considerable amounts of hydrocarbons not soluble in benzol and hydrocarbons of high molecular weight, such as napthalene.
    (a) Distillates:
        Light oil (benzol).
        Toluol.
        Xylol.
        Medium oil.
        Heavy oil.
        Anthracene.
    (b) Residues:
        Coal tar.
        Pitch.
IV. Wood tar.
    Contains, contrary to coal tar, little or no free carbon, but large amounts of phenols and acid water.
    (a) Distillates.
    (b) Residue:
        Wood-tar pitch.
V. Fat tars.
    Residues from the distillation of fats (petroleum oil, wool fat, and fatty acids) and neutral fats of considerable quantities known in the trade as stearine pitch, wool pitch, etc.
VI. Peat tar.
    Obtained by the dry distillation of peat.
VII. Oil-gas tar.
    Obtained from gas oil in the manufacture of gas.
VIII. Water-gas tar.
    Produced in carbureting water gas with gas oil.
IX. Bone tar.
    Molasses tar.
    Schlempe (residuum) tar.
        Produced by dry distillation of bones, molasses, schlempe, etc.

Classification by Clifford Richardson.—Another system of classification of asphalts adopted by Clifford Richardson is based upon the theory that all natural asphalts are produced from petroleum by the addition of sulphur, or oxygen, or both. He believes that asphalts are never made from petroleums of the paraffin series, but always from the unsaturated or cyclic hydrocarbons that are found in California and Texas oils; and he would classify the asphalts according to their solubility in various reagents, thus·

Richardson's classification of bitumen.

Bitumens.

- Gas:
  - Natural hydrocarbon gases.
  - Marsh gas.
- Petroleum:
  - Paraffin oils—
    - Consist of hydrocarbons and their derivatives, the lower members of which belong entirely to the paraffin series and have the general formula C_nH_{2n+2}, and are divided into—
      - (1) Those containing C_nH_{2n+2} hydrocarbons up to $C_{28}H_{58}$, with but traces of sulphur derivatives—Pennsylvania, West Virginia, Kentucky, Kansas, Colorado, etc.
      - (2) Those containing C_nH_{2n+2} hydrocarbons up to $C_{11}H_{24}$ and above that C_nH_{2n} and C_nH_{2n-2} polymethylenes with considerable amounts of sulphur derivatives—Ohio, Canada.
  - Cyclic oils—
    - Consist principally of polymethylene hydrocarbons of the series C_nH_{2n}, $C_nH_{2n-2}+C_nH_{2n-4}$, together with a certain amount of unsaturated hydrocarbons and their derivatives.
      - (1) Stable polymethylenes, consisting largely of naphthenes, C_nH_{2n}—Russian oils.
      - (2) Less stable polymethylenes, together with considerable amounts of unsaturated hydrocarbons and their nitrogen and sulphur derivatives, leaving an asphaltic residue on distillation—California.
  - Oils of mixed composition—
    - Semiasphaltic oils composed largely of stable paraffin and polymethylene hydrocarbons not readily attacked by sulphuric acid—Texas.
  - Maltha—
    - Known also as mineral tar, brea, and chapapote. Originates from polymethylene petroleums alone. Transition products between oil and asphalt.
  - Solid bitumens—
    - Consist largely of paraffin hydrocarbons, ozokerite, hatchettite, etc.
    - Consist of unsaturated cyclic hydrocarbons, terpenes, fossil resins, amber, etc.
    - Derived from or originate in polymethylene petroleums, the more volatile components consisting of dicyclic or tricyclic saturated hydrocarbons.
  - Asphalts—
    - Asphalt—
      - Numerous varieties—Trinidad, Venezuela, California, Cuba.
    - Glance pitch—
      - Consists largely of cyclic hydrocarbons which are attacked by strong sulphuric acid, but which otherwise are stable.
  - Manjak—
    - Yields high fixed carbon and a black powder.
  - Gilsonite—
    - Yields average fixed carbon and a brown powder, the more volatile components resembling sticky oleo resins rather than hydrocarbons found in the asphalts.
  - Grahamite—
    - Consists of hydrocarbons almost entirely insoluble in naphtha and yielding a higher percentage of fixed carbon on ignition. Melts with difficulty. The grahamites rapidly shade into pyrobitumens.

Pyrobitumens.

- Practically insoluble in chloroform or heavy petroleum hydrocarbons.
  - Derived from petroleum:
    - Albertite—
      - Varieties called nigrite, etc.
      - Wurtzilite.
  - Derived from direct metamorphoses of vegetable growth—
    - Anthracite.
    - Bituminous coal.
    - Lignite.
    - Peat (?).

Since in utilizing the solid natural hydrocarbons they are first dissolved, this classification by solubility has considerable value in their commercial use. It is not intended, however, for the classification of oil asphalts for roads.

For varnish making.—The various grades of hard asphaltum are used chiefly for varnishes. The art of making asphalt varnish is rather intricate. There is much prejudice in the choice of the asphaltum used. One manufacturer prefers, or finds more suitable for his especial product, asphalt from Barbados, known as manjak; another will use gilsonite exclusively. This gilsonite is in good demand, as is evident from the quantity produced. It sells wholesale in the varnish manufacturing centers as follows: New York and Boston, about $35.50 per short ton; Philadelphia, $35; Cleveland, $33; Detroit, $32.75; Cincinnati and Louisville, $32.50; and San Francisco, $32. Elaterite, which is also favored for making varnish, is worth about $10 more per net ton. It is with much difficulty soluble, but the elasticity of this asphalt enables the varnish to cling tenaciously to pliable metallic surfaces.

Ichthyol.—A peculiar form of asphaltic material found in Austria finds application, after appropriate chemical treatment, as a medicament under the name ichthyol. It is not prepared in the United States. The raw material from which it is derived is a fossiliferous deposit which is found near Seefeld in the Austrian Tyrol. The material mined at this place is carefully selected as to grade and is subjected to dry distillation. The distillate thus obtained is then sulphonated and subsequently neutralized with ammonia. The finished product resulting from this process is the commercial article known as ichthyol.

The ichthyol preparations, on account of their relatively constant composition, have been viewed by some authorities as definite chemical compounds, but the exact chemical composition of ichthyol has not yet been determined. This is, of course, readily understood when it is considered that the final composition of the product depends so largely upon many different factors—the individual characteristics of the particular deposit at Seefeld, which is controlled by the Ichthyol Co ; the selection of the material mined according to the standards developed by the experience of the manufacturers; the control of the temperatures in the distilling process; and the degree of sulphonation.

Road asphalts.—The classification of road asphalts is quite sharp and is made simply by series of tests which define the asphalts according to their viscosity, ductility, and other qualifications for use on road, pavement, or roof.

The asphaltic oils are usually graded by the percentage of asphalt contained. Ordinarily they contain from 30 to 60 per cent of solid asphalt, and are given a different number for each increase of 10 per cent of asphalt. Other manufacturers grade the product by the gravity expressed in degrees Baumé; thus the heaviest products sold as road oil would have a gravity of 14° to 16° B., the less asphaltic being graded as 16° to 18° B., and 18° to 20° B.

It should be noted also that "nonasphaltic" road oils are also sold in considerable quantity, but they are chiefly valuable for preventing dust rather than for serving as binding material. More temporary still are the "emulsified oils" also applied to roads.

Detailed studies as to the relative values of these materials and of the conditions governing the efficient use of one or another road oil or asphalt binder are constantly being made and published by the Office of Public Roads, United States Department of Agriculture. Owing chiefly to the work of this bureau, the use of asphaltic binders has increased very rapidly, and this outlet for asphaltic materials promises to take on still larger proportions in the near future. The smaller initial cost of road oils is naturally increasing their use temporarily, with the prospect, however, that eventually the use of more permanent hard-asphalt binders will prevail.

Use of oil asphalts.—When the use of asphalt as road material first became important the one commercial source of supply was the impure crude asphalt from Trinidad Lake, and the technology of asphalt pavements was adapted to the best methods of utilizing this material. Very durable and satisfactory roads of the well-known asphalt pavement type were made by a base of concrete upon which was spread a layer of Trinidad asphalt first freed from water by heating, then mixed with sand and spread while hot, and then steam rolled until smooth. Where transportation costs were not excessive, the asphaltic sandstones of Kentucky also furnished roads of somewhat the same character and led to the similar use of the asphalt-impregnated sea sands of the Pacific slope. Later the development, first, of liquid asphalt in Ventura County, Cal., and, then, of asphaltic residues from California oils gave a vastly greater supply of road material from oil refining. Every increase in the quantity of California oil refined has meant an additional quantity of asphalt to be disposed of, until the supply of California oil asphalt has become so great that the need of a larger market is felt.

The oils of Texas also yield a residue well adapted to the requirements of the paving and roofing trade, though the percentage of asphalt contained is, in general, less than in California crude oils.

Within late years Oklahoma crude oils have been piped to the Texas refineries and have largely displaced the Texas crudes for supplying the foreign and domestic markets with refined oils. The effect has been to apply the Texas crudes more especially to the production of lubricating oils and asphalts, and latterly to filling the growing demand for asphaltic road oil.

The manufacture of asphalts from these Texas refineries has fully kept pace with progress in the development of all kinds of asphalt products, from simple road-oil residues to the rubberoid materials made by blowing air or sulphur through the hot oil or residues.

Kansas oils and a few Oklahoma oils yield residues sufficiently asphaltic for similar use, and a portion of the trade is supplied from that region. Similarly the heavier Illinois crudes have been made to yield asphaltic road oils. Hence the refining centers of California, the Gulf coast, Kansas, Bridgeport, Ill., and latterly New York, have become important distributing points for asphalt products, and relative costs of these road materials in various cities depend chiefly upon the cost of transportation from the nearest of these few centers of distribution.

The great development of asphaltic oil on the east coast of Mexico and the low rate at which it can be transported to cities of the east coast of the United States have led to extensive development of asphalt refining facilities at New York and Philadelphia. Balt more and Boston will probably soon become original shipping poin also. The usual freight cost per ton-mile of asphalt products barrels or tanks is 1 cent, from which the wholesale cost of asphal can be reckoned approximately by the aid of the average prices points of production, given in the tables of production. In additio the following actual costs in various cities have been compiled by th aid of city officials:

Prices of asphalt in various cities.

City.	Asphaltic oils.		Asphalt.		
	30 to 60 per cent of asphalt.	Coal tar.	California, grade D.	Trinidad.	Paving
	Per gallon.	*Per gallon.*	*Per short ton.*	*Per short ton.*	*Per sho ton.*
Portland, Me	$0.08	....	....	....	....
District of Columbia [a]	.037 .049	$0.08½	....	....	....
Albany, N. Y	.039	....	....	....	....
Buffalo, N. Y	.03 .055	.0625 .095 .074	....	....	....
Chicago, Ill	.03	....	....	....	....
Cincinnati, Ohio	.04	.09 .10	$24.38	$20.50 22.00	$12.
St. Louis, Mo. [a]	.023	....	21.48 22.70	....	13. 13.5
Omaha, Nebr	....	....	22.60	....	....
Denver, Colo	.085	....	24.00	....	....

[a] Emulsified, St. Louis, Mo., $0.07 per gallon; District of Columbia $\left\{\begin{matrix}\$0.0548\\ .0365\end{matrix}\right\}$ per gallon.

The following statements of the average cost of bituminous roads is taken from the reports of the Office of Public Roads of the Department of Agriculture.

The average cost of bituminous macadam roads for the 10 States from which reports were received is $10,348 per mile for roads surfaced to a width of 15 feet and to a depth of 6 inches. The information received in regard to bituminous construction, however, is rather meager, and it is believed that it does not represent the average cost of country roads, as do the figures in regard to other methods of construction. The reason for this is that this method of construction is new and to some extent experimental. Furthermore, bituminous macadam roads have, up to the present time, been built only in the neighborhood of the larger cities, where the cost of labor is comparatively high and where the roads would naturally be surfaced to a greater width than the roads farther out in the country. It is believed, therefore, that the cost is greater than will be the case when this method of construction becomes more general and when this type of road building becomes standardized.[1]

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[1] Mileage and cost of public roads in the United States in 1909: Bull., Office of Public Roads, No. 41, Dept. Agr.

CHARACTERISTICS OF SOLID BITUMENS.

The following table shows the chief characteristics of the principal varieties of solid bitumens:

Chief characteristics of the principal varieties of solid bitumens.

Name.	Common name.	Specific gravity.	Color.	Fusibility.	Solubility.					Composition.			
					In gasoline (of 76° Baumé).	In ether.	In carbon bisulphide.	In carbon tetrachloride.	In turpentine.	Sulphur.	Oxygen.	Carbon.	Hydrogen.
										Per ct.	*Per ct.*	*Per ct.*	*Per ct.*
Uintaite	Gilsonite	1.068 to 0.170	Brilliant black powder. Streak lighter brown than albertite.	Easily fusible in candle flame; burns and acts like sealing wax, leaving sharp impression.	Soluble in petroleum ether.	Slowly; not wholly soluble as powder.	Entirely soluble.	Almost entirely soluble.	Freely soluble in hot turpentine; less soluble in cold turpentine.	1.55	......	88.79	9.31
Wurtzilite	Elaterite Tabbyite. Aeonite. Aegerite.	1.0227	Jet black by reflected light; deep red in thin plates.	Nonfusible in hot water, but softens, toughens, and becomes more elastic. In candle flame softens and melts and burns with bright flame.	Practically insoluble.	About 4 per cent soluble.	Partly soluble.	Slightly soluble.	Fairly soluble.	5.83	......	80.00	12.23
Wiedgerite [a]	Mineral Liver.	1.02	Liver brown	Soft; slightly elastic.	Soluble	Soluble	Soluble	Soluble	Soluble	......	......	......	......
Grahamite	Grahamite	1.145	Black, but powder and streak chocolate brown.	Melts imperfectly with decomposition of surface; in this state the interior may be drawn into threads.	Partly soluble.	Partly soluble.	Readily soluble.	......	Swells and nearly all dissolves.	Tr.	13.46	76.45	7.83
Impsonite [b]	......	1.175	Jet black	Does not soften in boiling water.	Insoluble	5 per cent soluble.	Completely soluble.	Partly soluble.	Almost insoluble.	1.47	2.00	86.57	7.26
Albertite	Albertite	1.08 to 1.11	Black; streak black; powder black to dark brown.	In spirit flame intumesces and emits gas, but does not melt; melts in closed tube.	......	About 4 per cent soluble.	Partly soluble.	do	30 per cent soluble.	Tr.	1.97	86.04	8.96

[a] An impure soft mass, containing much sulphur and water. Turns black on exposure. Has not yet been carefully described.
[b] See description by J. A. Taff, Bull. U. S. Geol. Survey No. 380, pp. 286–297.

Chief characteristics of the principal varieties of solid bitumens—Continued.

Name.	Common name.	Specific gravity.	Color.	Fusibility.	Solubility.					Composition.			
					In gasoline (of 76° Baumé).	In ether.	In carbon bisulphide.	In carbon tetrachloride.	In turpentine.	Sulphur.	Oxygen.	Carbon.	Hydrogen.
										Per ct	*Per ct.*	*Per ct.*	*Per ct.*
Oil asphalt	....	0.9825	Brownish black	....	90 per cent soluble.	90 per cent soluble.	99.9 per cent soluble.	99.9 per cent soluble.	99.9 per cent soluble.	0.30	....	84.1	15.2
Refined bitumens.	A	1.008	Black	Melts in hot water	80 per cent soluble.	80 per cent soluble.	99.9 per cent soluble.	99.5 per cent soluble.	99.5 per cent soluble.	.35	....	84.7	14.7
	B	1.023	do	Softens in hot water; does not melt.	75 per cent soluble.	76 per cent soluble.	99.8 per cent soluble.	99.2 per cent soluble.	do	.40	....	85.1	14.3
	C	1.039	do	Softens in hot water; melts in candle flame; tough and pliable at ordinary temperatures; brittle in very cold weather	70 per cent soluble.	73 per cent soluble.	99.7 per cent soluble.	99 per cent soluble.	do	.43	....	85.5	13.9
Ozokerite [a]	....	0.85–0.95	....	Fuses at 55° to 70° F	Soluble	Some varieties wholly soluble.	Soluble	Soluble	Soluble	Tr.	Tr.	85.25	15.09

[a] Black from contained asphalt.

UNITED STATES GEOLOGICAL SURVEY PUBLICATIONS ON ASPHALT.

The following list comprises the more important papers relative to asphalt published by the United States Geological Survey or by members of its staff. The Government publications, except those to which a price is affixed, can be obtained free by applying to the Director, United States Geological Survey, Washington, D. C. The priced publications may be purchased from the Superintendent of Documents, Government Printing Office, Washington, D. C.

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SMITH, C. D. (See Taff, J. A., and Smith, C. D.)

TAFF, J. A., Albertite-like asphalt in the Choctaw Nation, Indian Territory: Am. Jour. Sci., 4th ser., vol. 8, 1899, pp. 219–224.

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——— Grahamite deposits of southeastern Oklahoma: Bull. 380, 1909, pp. 286–297.

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TAFF, J. A., and SMITH, C. D., Ozokerite deposits in Utah: Bull. 285, 1906, pp. 369, 372. 60c.

VAUGHAN, T. W., The asphalt deposits of western Texas: Eighteenth Ann. Rept., pt. 5, 1897, pp. 930–935.

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FELDSPAR AND QUARTZ.

By Jefferson Middleton.

FELDSPAR.

INTRODUCTION.

The feldspar industry of the United States in 1911, as indicated by the figures which follow, made considerable progress and showed the largest production and value yet recorded, the production being greater by 901 tons in quantity and $20,064 in value than that of 1907, the year of maximum production until 1911, and more than twice as great as it was in 1903. The use of feldspar of the lower grades for poultry grit, roofing, etc., seems to be on the increase, and in 1911 a small quantity was used as railroad ballast.

COMPOSITION, OCCURRENCE, AND USES.

Bulletin 420 of the Survey, "Economic geology of the feldspar deposits of the United States," by Edson S. Bastin, published in 1910, is so complete a treatise on the subject that it is not deemed necessary in this place to go into detail regarding the composition and occurrence of feldspar in the United States. All who are interested in the subject are referred to that bulletin, which may be had on application to the Director, United States Geological Survey, Washington, D. C.

Feldspar is a compound of silica and one or more of the bases—potash, soda, and lime. There are two principal commercial varieties—the potash spar and the soda spar. Both of these may be present in the same deposit or in the same crystal. The principal members of the potash group are orthoclase and microcline. These varieties are so nearly alike in chemical composition ($KAlSi_3O_8$, or $K_2O.Al_2O_3.SiO_2$) and physical properties as to be considered commercially identical. The theoretical composition of pure orthoclase or microcline is silica 64.7 per cent, alumina 18.4 per cent, and potash 16.9 per cent. The potash may be partly or completely replaced by soda. When the soda content is greater than the potash content the feldspar is called anorthoclase.

Potash feldspars range in color from white to reddish and some are gray. The soda feldspars vary from white to pale green in color. When first taken from the quarry feldspar is so hard that it is with difficulty scratched by a knife.

The most of the feldspar mined in the eastern part of the United States is of the potash or soda variety or a mixture of the two. These varieties are used in the pottery industry because after being melted and cooled they form a glass, whereas lime-soda feldspar under these conditions becomes crystalline.

In 1911 deposits in California, Connecticut, Maine, Maryland, Minnesota, New York, North Carolina, Pennsylvania, and Virginia were worked. North Carolina appeared for the first time as a produc and new deposits were opened in Maryland and Virginia.

The principal use of feldspar is in the manufacture of potte enamel ware, enamel brick, and electrical ware. Of these the m important is its use in the body and glaze of the various grades pottery and vitrified sanitary ware, in which it constitutes from to 35 per cent. Its value in pottery is that it melts at a lower poi than the other ingredients and serves as a flux, binding the clay a quartz particles together. In glazes the percentage of feldspar us is higher than in the body and runs from 30 to 50 per cent. Oth uses of feldspar, which do not require the high grade demanded by t pottery trade, are in the manufacture of emery and corundum whee where it serves as a flux; in the manufacture of opalescent glass; as poultry grit; as a constituent of roofing material; and as balla Small quantities of the purest grades of potash feldspar are used the manufacture of artificial teeth. For this purpose it brings t highest prices—from $6 to $8 per barrel of 350 pounds. It is al used in the manufacture of scouring soaps and window wash.

PRODUCTION.

The production of feldspar in 1911 was 92,700 short tons, valued $579,008. This was an increase over 1910 of 11,598 tons, or 14. per cent in quantity, and of $76,556, or 15.24 per cent, in value. Th production of crude spar was 28,131 short tons, valued at $88,39 an increase of 3,476 tons, or 14.10 per cent, and of $6,429, or 7.84 p cent, as compared with 1910. The production of ground spar w 64,569 short tons, valued at $490,614, an increase of 8,122 tons, 14.39 per cent, and of $70,127, or 16.68 per cent, as compared with th production of 1910. The average price per ton in 1911 for crude sp was $3.14, compared with $3.32 in 1910, and for ground spar it w $7.60, compared with $7.45 in 1910. Of the output in 1911, 13,8 short tons, valued at $55,835, were used for abrasive material, roofin and poultry grit. Of the total quantity, the crude constituted 30.3 per cent, and the ground 69.65 per cent; of the value, the crude w 15.27 per cent and the ground was 84.73 per cent.

The following tables show the production and value of feldspar i 1910 and 1911 by States, and from 1907 to 1911 by varieties. Thes figures include abrasive feldspar, and show the marketed produc rather than the quantity actually quarried.

Production of feldspar in 1910–11, by States, in short tons.

1910.

State.	Crude.		Ground.		Total.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Connecticut	9,996	$32,903	8,743	$57,071	18,739	$89,9
Maine	280	625	20,482	195,838	20,762	196,4
Maryland	7,457	25,290	2,520	22,050	9,977	47,3
New York	550	2,576	11,862	45,288	12,412	47,8
Pennsylvania	3,751	12,611	11,340	92,140	15,091	104,7
California, Massachusetts, Minnesota, and Virginia	2,621	7,960	1,500	8,100	4,121	16,0
Total	24,655	81,965	56,447	420,487	81,102	502,45

Production of feldspar in 1910–11, by States, in short tons—Continued.

1911.

State.	Crude.		Ground.		Total.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
California	(a)	(a)			(a)	(a)
Connecticut	(a)	(a)	(a)	(a)	16,497	$73,557
Maine	(a)	(a)	25,864	$246,005	25,976	246,305
Maryland	10,132	$31,925	(a)	(a)	12,694	56,265
Minnesota			(a)	(a)	(a)	(a)
New York	(a)	(a)	18,213	77,470	18,800	79,926
North Carolina	(a)	(a)			(a)	(a)
Pennsylvania	2,967	9,078	(a)	(a)	13,284	101,090
Virginia	(a)	(a)			(a)	(a)
Other States [b]	15,032	47,391	20,492	167,139	5,449	21,865
Total	28,131	88,394	64,569	490,614	92,700	579,008

[a] Included in "Other States."
[b] Includes all feldspar produced by less than 3 producers in 1 State.

Production of feldspar, 1907–1911, in short tons.

Years.	Crude.		Ground.		Total.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
1907	31,080	$101,816	60,719	$457,128	91,799	$558,944
1908	18,840	65,780	51,634	362,773	70,474	428,553
1909	25,506	70,210	51,033	354,392	76,539	424,602
1910	24,655	81,965	56,447	420,487	81,102	502,452
1911	28,131	88,394	64,569	490,614	92,700	579,008

FELDSPAR INDUSTRY BY STATES.

California.—The only quarry in California shipping feldspar in 1911 was that of John C. Jens near Chualar, Monterey County. This material is used for making pottery.

Connecticut.—Connecticut was the third largest producer of feldspar in 1911, being exceeded only by Maine and New York. Its production in 1911—16,497 tons, valued at $73,557—was less by 2,242 short tons and $16,417 than that of 1910. The price in Connecticut for crude ranged from $2.77 to $4.25 per ton, with an average of $3.01; for ground, the range was from $5.50 to $15, with an average of $6.25, the average for all feldspar being $4.46 per ton. There were four producers. One company made no sales in the State. Connecticut's feldspar is used for pottery, glass, abrasives, soaps, and tiles.

Maine.—Maine was the leading feldspar-producing State in 1911, as in 1910, reporting 25,976 tons, valued at $246,305. This was 28.02 per cent of the total output and 42.54 per cent of the total value. The quantity increased 5,214 tons, or 25.11 per cent, and the value $49,842, or 25.37 per cent, as compared with the production of 1910. The average price per ton received for crude Maine spar in 1911 was $2.68, and for ground $9.51, as compared with $2.23 and $9.56, respectively, in 1910. There were four producers. The feldspar produced in Maine is used for pottery and tile.

Maryland.—A new quarry opened in Maryland during 1911, about 4 miles west of Laurel, in Montgomery County, was operated by the

Earth Products Co. Development work was done during the year, but no shipments were made. Maryland's production showed an increase in both quantity and value, the former from 9,977 tons, valued at $47,340, in 1910 to 12,694 tons, valued at $56,265, an increase of 2,717 tons, or 27.23 per cent in quantity, and of $8,925, or 18.85 per cent, in value. The average price per ton for crude in 1911 was $3.15, and for ground $9.50; in 1910 these prices were $3.39 and $8.75. Maryland was the fifth State in production and value of feldspar in 1911. There were 11 producers in Maryland in 1911.

Massachusetts.—There was no production of feldspar in Massachusetts in 1911, the quarry near Blandford, Hampden County, making no shipments.

Minnesota.—The one quarry in Minnesota, the product from which was used exclusively for abrasive paper, was not in operation in 1911. Small shipments were made in 1911 from material mined in 1910.

New York.—The most of New York's ground product was used for roofing, poultry grit, and concrete facing. The output for these purposes increased very considerably in 1911. There were one idle and three operating firms in New York in 1911. The average price per ton for crude in 1911 was $4.18 and for ground $4.25. New York was the second largest producer of feldspar in 1911, its production being 18,800 short tons, valued at $79,926. This was an increase over 1910 of 6,388 tons, or 51.47 per cent, in quantity and of $32,062, or 66.99 per cent, in value.

North Carolina.—North Carolina entered the list of feldspar-producing States for the first time in 1911. The Carolina Mineral Co. (Inc.), with a quarry located in Mitchell County, made its first shipment in 1911. An analysis of this spar by Wiley & Hoffman, of Baltimore, shows it to run 12.56 per cent potash and 2.98 per cent soda.

Pennsylvania.—The production of feldspar in Pennsylvania decreased from 15,091 short tons in 1910, valued at $104,751, to 13,284 tons, valued at $101,090, in 1911—a decrease of 1,807 tons, or 11.97 per cent, in quantity and of $3,661, or 3.49 per cent, in value. The Edgemont Feldspar Co., with quarry and mill in Edgemont Township, Delaware County, conducted experimental work, but made no shipments. Analyses of its material show it to run 14 per cent potash. There were six producing and four idle operators in Pennsylvania in 1911. The average price per ton in Pennsylvania in 1911 was $3.06 for crude and $8.92 for ground. In 1910 these figures were $3.36 and $8.13, respectively. The feldspar produced in Pennsylvania in 1911 was used for pottery, tile, enameled ware, and glassware. Pennsylvania was fourth in production and second in value of feldspar marketed in 1911, reporting 14.33 per cent of the total product and 17.46 per cent of the total value.

Vermont.—No feldspar was marketed in Vermont in 1911. The A. L. Stone Manufacturing Co., of Chester, completed during the latter part of the year a plant for grinding. The material quarried here will be used for poultry grit.

Virginia.—The Dominion State Mines Corporation, of Farmville, was the only producer of feldspar in Virginia. The quarries of this company were described in the report for 1910. Large shipmenst were made by the company in 1911. An analysis by Dr. Carpenter, of the Virginia-Carolina Co., of Richmond, shows it to contain 13 per cent of potash. The Virginia Asbestos Co., of Bedford City, reported that development work was being done on a deposit of feldspar on the property of the company near Bedford City and that shipments would be made during 1912. An analysis of the material by the Rose Polytechnic Institute shows that it contains 14.92 per cent of potash, 18.90 per cent of alumina, and 0.33 per cent of iron.

CANADA.

The production[1] of feldspar in Canada in 1911 was 17,718 tons, valued at $51,924, compared with 15,809 tons in 1910, valued at $47,667. This was an increase of 1,909 tons, or 12.07 per cent, in quantity and of $4,257, or 8.93 per cent, in value. The average price per ton in 1911 was $2.93, and in 1910 it was $3.02.

QUARTZ.

INTRODUCTION.

Quartz (SiO_2), the oxide of silicon, is the most abundant of minerals. It occurs in a great many different forms, such as sand, tripoli, sandstone, quartzite, etc. In some forms, such as rose and smoky quartz and amethystine quartz, it has a gem value. This chapter deals only with massive crystalline quartz, with flint, and with quartzite that is used for other than building or paving purposes. Sand and other varieties of quartz are discussed in other chapters of this volume.

Massive crystalline quartz is usually white, but sometimes rose-colored or smoky. It occurs in veins or dikelike masses unmixed with other minerals, or as a constituent of pegmatite. In the latter case, it is usually produced as an accessory product in the mining of feldspar. The States producing massive crystalline quartz in 1911 were in the order of the value of their output: Maryland, Wisconsin, Tennessee, Pennsylvania, Connecticut, New York, Michigan, Arizona, and Massachusetts. In quantity of material produced they ranked as follows: Tennessee, Arizona, Maryland, New York, Pennsylvania, Wisconsin, Connecticut, Michigan, and Massachusetts. For descriptions of the occurrence the reader is referred to the reports of Edson S. Bastin.[2]

USES.

Quartz as treated in this chapter is used for many purposes. The principal uses are in the manufacture of pottery, paints, scouring soap, and as a wood filler. In pottery the use of quartz diminishes the shrinkage in the body of the ware; it is also used in many glazes. Quartz for use in pottery should be nearly free from iron-bearing minerals—less than 0.5 per cent. Considerable quantities of ground quartz are used in the manufacture of paint, in some cases as much as one-third of the total pigment used being of this material. Crystalline quartz is superior to silica sand for this purpose because of the angularity of more; Thomas & Son, Marriottsville; and H. Clay Whiteford & Co., Flintville. One quarry was idle and one firm retired from business. Maryland's quartz was used in the manufacture of pottery and for wood filler, soap, and paint.

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[1] Preliminary report on the mineral production of Canada during the calendar year 1911, Canada Dept. Mines, 1912.

[2] Bull. U. S. Geol. Survey No. 315, 1907, pp. 394–399: Mineral Resources U. S. for 1907, pt. 2, U. S. Geol. Survey, 1908, pp. 846–848; idem for 1909, pt. 2, 1911, pp. 907–910; idem for 1910, pt. 2, 1911, pp. 963–968.

Massachusetts.—The only producer of quartz in Massachusetts in 1911 was the Enos Adams Co., with quarry near Cheshire, Berkshire County. This product was used for facing cement brick, blocks, etc., and for soap and powder.

Michigan.—In Michigan the only producer, as in 1910, was the Michigan Quartz Silica Co., with mine at Ishpeming and mills at Ishpeming, Mich., and Milwaukee, Wis. Its product was used for wood filler, paint, and abrasives.

New York.—There were two producers in the State in 1911—the Bridgeport Wood Finishing Co., and P. H. Kinkel's Sons, at Bedford, Westchester County. The former was the lessee of the Kinkel quarry, but the latter ground a small quantity of quartz purchased from small producers.

Pennsylvania.—There were two producing operators in 1911 in Pennsylvania—the Columbia Flint Co., with quarry near Bendersville, and Harry T. A. Rhodewalt, with quarry at Cornog station. The Silica Stone Works of Planebrook was not in operation.

Tennessee.—Tennessee was the largest producer of quartz in 1911. The Tennessee Copper Co. reported a very much larger production in 1911 than in 1910. The grade was also much lower. This large production is partly responsible for the big increase in the output of crude quartz and for the low average value for this variety. It was used as a flux in copper smelting.

Wisconsin.—The Wausau Quartz Co. was the only producer in Wisconsin in 1911. An analysis of the material of this company by Prof. Daniels shows it to contain 99.07 per cent silica, 0.17 per cent iron oxide, and 0.52 per cent of alumina. It is used as a filtering sand, for roofing, as an abrasive, for chicken grit, and in concrete work.

IMPORTS OF FLINT PEBBLES.

The imports for consumption of flint pebbles into the United States in 1911 were valued at $236,158, as compared with $307,286 in 1910, $301,547 in 1909, and $219,754 in 1908.

CANADA.

The production[1] of quartz in Canada in 1911 was 60,526 tons, valued at $83,865, as compared with 88,205 tons, valued at $91,951 in 1910. This was a decrease of 27,679 tons, or 31.38 per cent, in quantity and of $8,086, or 8.79 per cent, in value. The average price per ton in 1911 was $1.39, and in 1910 it was $1.04.

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[1] Preliminary report on the mineral production of Canada during the calendar year 1911, Canada Dept. Mines.

FULLER'S EARTH.

By Jefferson Middleton,

INTRODUCTION.

There were no remarkable features connected with the fuller's earth industry in 1911, except possibly the large production by a small number of operators. New deposits have been reported from time to time, but in many the high standard of quality required is not found and few of the deposits are worked. Of the large number of known deposits, located in every section of the country, but 13 were worked in 1911. The reasons for the small number of deposits being worked are principally the few uses of the material, the small though growing market, the deficiency in quality of many of the American earths, and the lack of capital to develop those that show good quality. The inaccessibility of some of the deposits no doubt prevents their development.

Fuller's earth is a claylike material whose distinguishing chemical characteristic is its high content of combined water. In color it ranges from gray to dark green; when dry it often adheres to the tongue, though this is not a certain test, as this quality is found in some other clays. A chemical analysis is of little value in determining the value of fuller's earth, actual use being the only satisfactory test.

OCCURRENCE.

Fuller's earth occurs in Alabama, Arkansas, California, Colorado, Florida, Georgia, Massachusetts, Minnesota, Nebraska, New York, South Carolina, South Dakota, Texas, Utah, and Virginia, but it was produced in 1911 in only seven States—Arkansas, California, Florida, Georgia, Massachusetts, South Carolina, and Texas.

USES.

The principal use of fuller's earth in this country is the bleaching, clarifying, or filtering of fats, greases, and oils. The original use, from which it derives its name, the fulling of cloth, is now a minor one. Experience has shown that the domestic earths are better adapted for use on mineral oils and that the imported earths are better for fats and vegetable oils.

Four less active operators reported in 1911 than in 1910. Notwithstanding the comparatively small number of producers, the output has almost steadily increased from the small beginning of

1895, when but 6,900 short tons were reported, valued at $41,400, or $6 per ton, to 1911, when 40,697 short tons, valued at $383,124, or $9.41 per ton, were reported. The prospects for 1912 appear to be bright and the production will probably exceed that of 1911. A number of deposits, the products of which had not at the close of 1911 been put on the market, were being exploited and promise to have a production in 1912.

The imports of fuller's earth were also the largest ever recorded both in quantity (18,224 short tons) and value ($143,594), so that the consumption of fuller's earth was 58,921 short tons, valued at $526,718. Of this the domestic production composed 69.07 per cent in quantity and 72.74 per cent in value.

PRODUCTION.

The following table shows the production of fuller's earth in the United States from the inception of the industry:

Production of fuller's earth in the United States, 1895–1911, in short tons.

Year.	Quantity.	Value.	Average price per ton.	Year.	Quantity.	Value.	Average price per ton.
1895	6,900	$41,400	$6.00	1904	29,480	$168,500	$5.72
1896	9,872	59,360	6.01	1905	25,178	214,497	8.52
1897	17,113	112,272	6.56	1906	32,040	265,400	8.28
1898	14,860	106,500	7.17	1907	32,851	291,773	8.88
1899	12,381	79,644	6.43	1908	29,714	278,367	9.37
1900	9,698	67,535	6.96	1909	33,486	301,604	9.01
1901	14,112	96,835	6.86	1910	32,822	293,709	8.95
1902	11,492	98,144	8.54	1911	40,697	383,124	9.41
1903	20,693	190,277	9.20				

In 1911 the production was the largest recorded; it was larger by 7,875 short tons, or 23.99 per cent, in quantity and $89,415, or 30.44 per cent, in value than the production of 1910, and larger by 21.53 per cent in quantity and 27.03 per cent in value than the production for 1909—the maximum output and value until 1911. The highest average price per ton, $9.41, was also attained in 1911, and the lowest, $5.72, in 1904.

The following tables show the production of fuller's earth in 1910 and 1911 by States:

Production of fuller's earth in the United States in 1910 and 1911, by States, in short tons.

1910.

State.	Number of operating producers reporting.	Quantity.	Value.	Average price per ton.
Arkansas	4	2,563	$29,137	$11.37
California and Colorado	3	568	8,085	....
Florida	3	18,832	170,267	9.04
Georgia, Massachusetts, and South Carolina	4	9,995	77,638	....
Texas	3	864	8,582	9.93
Total	17	32,822	293,709	8.95

Production of fuller's earth in the United States in 1910 and 1911, by States, in short tons—Continued.

1911.

State.	Quantity.	Value.	Average price per ton.
Florida	27,658	$265,571	$9.60
Georgia and South Carolina	10,543	95,050	9.01
Other States [a]	2,496	22,503	9.02
Total	40,697	383,124	9.41

[a] Includes Arkansas, California, Massachusetts, and Texas.

Florida continues to be the leading producing State. In 1911 it reported 67.96 per cent of the quantity and 69.32 per cent of the value of the entire production; for 1910 these percentages were 57.38 and 57.97, respectively. The other States in the order of their rank in 1911 were: Georgia, Arkansas, Texas, Massachusetts, California, and South Carolina. The average price per ton in the States combined in the table was as follows: Arkansas $10, California $10.30, Georgia $9.04, Massachusetts $5, South Carolina $7, and Texas $9.66.

NOTES ON THE FULLER'S EARTH INDUSTRY BY STATES.

Alabama.—The plant of the Standard Fuller's Earth Co., Mobile, was idle during 1911.

Arkansas.—Only two of the five operators of this State were working in 1911—the Arkansas Fuller's Earth Co., at Fairplay, and John Olsen, at Klondyke.

California.—California had only two producers of fuller's earth in 1911—the Western Fuller's Earth Co., at Vacaville, and the Eight Oil Co., at Bakersfield. The latter, which has been working in a more or less experimental way, reports that it has installed a mill and will commence operations on a commercial scale in 1912.

Colorado.—No fuller's earth was produced in Colorado in 1911.

Florida.—The industry in Florida was in a good condition in 1911. Three operators reported sales—the Atlantic Refining Co. and the Florida Fuller's Earth Co., at Ellenton, and the Floridin Co., at Quincy Junction. The Floridin Co. reported a large increase in capacity by the equipment of a plant at Jamieson, Gadsden County. The Fuller's Earth Co., at Midway, Gadsden County, reported a plant in course of construction. Hence the prospects for a large production in 1912 in Florida are good. The demand is said to have exceeded the supply in 1911.

Georgia.—Two companies reported sales of fuller's earth in Georgia in 1911—the Lester Clay Co., at Attapulgus, and the General Reduction Co., at Dry Branch.

Massachusetts.—There has been but one firm producing fuller's earth in Massachusetts for several years—Messrs. J. E. & R. M. Farnsworth, of Lancaster.

Minnesota.—The only known deposit of fuller's earth in Minnesota, which belongs to the P. D. McMillan Land Co. and is located about midway between Austin and Albert Lea, in Freeborn County, wa idle in 1911.

New York.—The only deposit of fuller's earth in New York is tha of the New York Fuller's Earth Co., at McConnellsville. This deposi was not worked in 1911.

South Carolina.—Of the two companies in South Carolina, the Suga Loaf Mining Co. and the National Earth Co., only the latter was i operation in 1911.

South Dakota.—The plants of the Argyle Fuller's Earth Co., a Custer, and of William Bodenner, near Fairburn, were idle in 1911.

Texas.—Of the several deposits of Texas in 1911 sales were mad only from those controlled by the Commercial Pulverizing Co., Lena Fayette County, and the Fuller's Earth Co., Somerville, Burleso County. The largest deposits in this State are reported by th University of Texas, Bureau of Economic Geology and Technology as being located in Fayette County.

Utah.—The only deposit of fuller's earth in Utah known to the Survey was not worked in 1911. It is located in San Pete County and is owned by the estate of William F. Young.

IMPORTS.

The following table shows the imports of fuller's earth from 1897 to 1911, inclusive:

Fuller's earth imported for consumption into the United States, 1897 to 1911, in short tons.

Year.	Unwrought or unmanufactured.			Wrought or manufactured.			Total.		
	Quantity.	Value.	Average price per ton.	Quantity.	Value.	Average price per ton.	Quantity.	Value.	Average price per ton.
1897[a]	2,585	$14,283	$5.53	2,395	$20,037	$8.37	4,980	$34,320	$6.89
1898	2,283	15,921	6.97	7.073	55,123	7.79	9,356	71,044	7.59
1899	4,192	23,194	5.53	7,366	46,446	6.31	11,558	69,640	6.03
1900	2,723	14,750	5.42	6,431	50,047	7.78	9,154	64,797	7.08
1901	3,266	17,230	5.28	8,792	63,467	7.22	12,058	80,697	6.69
1902	4,239	26,635	6.28	10,895	75,945	6.97	15,134	102,580	6.78
1903	4,260	28,339	6.65	12,840	92,332	7.19	17,100	120,671	7.06
1904	1,975	9,546	4.83	8,247	64,460	7.82	10,222	74,006	7.24
1905	1,705	12,798	7.51	12,858	93,199	7.25	14,563	105,997	7.28
1906	2,905	20,129	6.93	11,920	88,566	7.43	14,825	108,695	7.33
1907	2,490	16,833	6.76	13,916	105,388	7.57	16,406	122,221	7.45
1908	2,363	16,242	6.87	9,803	77,171	7.87	12,166	93,413	7.68
1909	1,802	12,492	6.93	10,950	88,659	8.10	12,752	101,151	7.93
1910	2,160	14,399	6.67	14,427	118,146	8.19	16,857	132,545	7.86
1911	1,881	10,877	5.78	16,343	132,717	8.12	18,224	143,594	7.88

[a] July to December.

The increase in the imports in 1911 over 1910 was only 1,367 tons, or 8.11 per cent, in quantity, and $11,049, or 8.34 per cent, in value. Compared with the domestic production and value, it will be seen that the imports are increasing at a much slower rate.

In the following table is shown the quantity and value of the fuller's earth imported from 1867 to 1883, by fiscal years. The wrought and the unwrought earths were not classified separately during this period. From July 1, 1883, to June 30, 1897, fuller's earth was not reported separately in the customhouse returns to the Treasury Department, but were included in minerals "not elsewhere specified."

Imports of fuller's earth into the United States, 1867–1883, in short tons.

Year ending June 30—	Quantity.	Value.	Year ending June 30—	Quantity.	Value.
1867	314	$3,113	1876	277	$3,097
1868	236	2,522	1877	448	4,460
1869	363	3,587	1878	375	4,095
1870	268	2,619	1879	404	4,269
1871	325	3,383	1880	647	6,925
1872	307	3,358	1881	300	3,207
1873	281	2,978	1882	1,017	11,444
1874	310	3,440	1883	1,390	14,309
1875	336	3,694			

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GEMS AND PRECIOUS STONES.

By Douglas B. Sterrett.

INTRODUCTION.

An important feature of the gem-mining industry in the United States during 1911 was the result of prospecting at the Turner emerald mine near Shelby, N. C. The quality of some of the gems and the value of all gem material found in this deposit with a limited amount of development work are promising. Gems valued at $100 to $200 per carat have been obtained, and the quality of the average run of the emeralds probably equals that of South American emeralds. The mine has been purchased by New York men, who expect to test it thoroughly.

Much interest has been displayed in chalcedony and quartz gems, such as agates, moss agate, jasper, and bloodstone, resulting in an increased output. Moss agates of very fine quality and a few gems showing quite remarkable landscapes were cut in Montana. Discoveries of new deposits of bloodstone and of a beautiful variety of chalcedony, resembling St. Stephen stone, in California have proved of interest. Beach-pebble gems were polished along the coast of California and Oregon as usual, and furnished many attractive souvenir gems for tourists. Renewed activity in sapphire mining in Montana resulted in a large output. The mines of the Yogo American Sapphire Co. and of the New Mine Sapphire Syndicate in Fergus County produced many stones of a fine blue color, and the placer deposits of Granite County, Deerlodge County, and along Missouri River contributed a large quantity of varicolored stones for gems and mechanical purposes.

Opaque blue and green gems, such as turquoise, variscite, and copper-ore gems, were used in some quantity, but the production was much smaller than during the preceding two years. Much of the material placed on the market as finished gems was mined in previous years. The demand for tourmaline and kunzite declined and was supplied chiefly from stocks on hand. New trade names are continually appearing for new forms of well-known minerals or peculiar mixtures of minerals cut for gems. Some of these trade names are mentioned in this report in order that the public may know the nature of such stones when offered for sale.

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for information on moss agate and mocha stone occurrences in Montana; Mr. F. M. Myrick, of Randsburg, Cal., for specimens of St. Stephen stone for examination; Mr. F. C. Faxon, of Silver Lake, Cal., for specimens of copper-stained and amethystine chalcedony; Mr. Maynard Bixby, of Salt Lake City, Utah, for specimens of jasper-like chalcedony; Mr. W. B. Penniston, of Ashland, Oreg., for specimens of chalcedony and agate and notes on the localities; Mr. F. H. C. Reynolds for notes on occurrence of aquamarine near Royalston, Mass.; and Mr. George L. English, of Shelby, N. C., for information on emerald occurrences in North Carolina.

AGATE.

MONTANA.

Moss agate and mocha stone of fine quality occur in Montana. The agates have been found chiefly on the west side of Yellowstone River from the Dakota line up to and (reported) above Yellowstone Park. They range back from the river over many miles of country, where they are gathered by the ranchers and sheep herders. The agates are distributed over the surface of the ground, in the gravel along creek and river beds, and over some of the grass-covered buttes. The ones collected all lie at the surface or only partly buried. They occur in pebbles, cobbles, and in rough masses ranging from the size of a hazelnut to pieces weighing 12 pounds. Chemical tests made on a number of the black and reddish-brown spots broken from rough specimens showed the presence of both manganese and iron, confirming the generally accepted idea as to the nature of the dendrites in mocha stone.

The rough specimens of agate examined consist of fragments and a chipped pebble more than 2 inches thick. The rounded form of the pebble may be due in part to the shape of the cavity in which the agate was deposited and in part to attrition during transportation along with the associated gravels. The interior of the pebble and the fragments of agate consist of translucent gray to blue-gray chalcedony. Some of it shows a banded structure, and some an even texture. Black and brown dendritic spots are scattered irregularly throuh the agate and in places there are seams and irregular patches of the same color. Reddish-brown, red, and bright-red dendrites, banding, and other markings also occur in the agates. The texture of the dendrites ranges from cloudy patches to branching tufts and fibers as delicate as those found in the finest moss and ferns.

By taking advantage of the arrangement of the dark seams and dendritic patches, patterns are obtained that resemble moss, sea growths, ferns, rushes, trees, and even landscapes with water and islands. The cut gems consist of stones suitable for use in brooches, stick pins, watch fobs, belt buckles, etc. The markings were present in different shades of red, reddish brown light brown, dark brown to black.

Three specimens cut into fob gems displayed very attractive markings. One of the fobs measuring 15 by 18 millimeters contained numerous black spots 2 to 3 millimeters in diameter, and one larger dendrite, 8 millimeters across, resembling a sunflower. Another fob stone 27 by 31 millimeters gave the effect of a small landscape, such as an overgrown garden with untrimmed shrubbery, hawthorn, or other bushes. The shrubbery was represented by black dendrites 5 to 9 millimeters high.

The best specimen was an elongated stone cut "en cabochon," 73 millimeters long, 20 millimeters wide, and 5 millimeters thick, portraying many wooded islands scattered through a lake or other body of water—"Thousand Islands," as suggested by several persons who examined the stone. This stone is valued at $250. A slight banding of the agate heightened the resemblance to water and also added a slight cloud effect to the landscape. The fine quality of this gem was best brought out by viewing in transmitted light, though its great beauty was evident in reflected light. The scene was similar and very perfect viewed from either side of the stone. This gem would make a unique and beautiful brooch or would grace the collection of any museum in which it might be placed.

The gems cut from the Montana moss agate or mocha stone command good prices, bringing anywhere from $1 to $200 or $300 apiece. Some of the smaller stones suitable for stick pins, if the mossy or fernlike patterns are particularly delicate and beautiful, bring $25 apiece. Large quantities of agate are cut which yield less attractive gems, and stones as fine as those described above are rare. The value of such gems as have been described lies in the fact that they can not be duplicated.

CALIFORNIA.

Specimens resembling the St. Stephen stone variety of agate from a new locality 15 miles east of Indian Springs, San Bernardino County, have been examined. This stone has been called "myrickite" locally and a quantity has has been cut and sold for good prices. It has been obtained from a shallow shaft in a "malpaís" lava hill where it occurs in bunches and small masses. It consists of translucent gray chalcedony through which bright blood-red spots and patches of color are irregularly distributed. In some specimens the red is thinly scattered through the agate and in others it is abundant. The majority of the red markings are irregular patches or tangled stringlike masses, but some are more or less round spots as in St. Stephen stone. The polished gems with the peculiar patterns of brilliant red in translucent chalcedony are highly attractive.

Specimens of copper-stained chalcedony from the south end of Death Valley, 5 miles west of the south end of the Mesquite Mountains, and of amethystine chalcedony about 8 miles south of this locality have been examined. The copper-stained variety is translucent and incloses spots and patches of blue and greenish-blue copper salts. The effect in some specimens is similar to that of the blue chrysoprase from Miami, Ariz. This chalcedony contains frequent small crystal-lined cavities so that careful selection would be necessary to secure material for cutting. The amethystine chalcedony is rather cloudy violet colored and massive and has a moderately even texture. It would cut into rather pretty low-priced gems.

UTAH.

Specimens of red jasper-like chalcedony and quartz have been received from a locality near San Rafael River, in Emery County, Utah. Much of this would be called chalcedony and agate or carnelian, but portions are so heavily impregnated with iron oxide as to be more like jasper. In places the chalcedony grades into crystallize quartz. The material occurs in masses and aggregations of spherulites with mammillary and botryoidal structures. The spherulite range from minute size to over a centimeter in diameter and show beautiful concentric agate banding of thin gray, white, and re layers. A radiated texture may or may not be visible and in som spherulites tiny radial quartz crystals occur in the center or in layer A few of the spherulites exhibit very little internal structure o merely have spots of red near the center surrounded by gray chalcedony with even texture. In some specimens the spherulites ar large or a number have been cemented together by chalcedony so tha stones of sufficient size for cutting are obtained. Some of the gem are said to give the effect of thomsonite with deep jasper-red tint in gray matrix. As small fancy agates some of the larger spherulite would be very effective.

In some specimens spherulites of various sizes are thickly distributed through granular crystallized calcite. Many of the spherulite are isolated but some are bunched in botryoidal masses as show when the calcite gangue is dissolved by acid. One specimen i described as resembling the cast of an ammonite shell. It was no possible to determine the nature of this from the sample submitted It consisted of many spherulites cemented together with chalcedony with cavities lined with small crystals of quartz and calcite. The sample examined evidently came from a disklike specimen about 2 inches thick.

OREGON.

Chalcedony, agate, and jasper-like agate have been found near Rogue River and Eagle Point, and for some distance along Rogue River valley. The chalcedony is translucent and gray with a slight agate banding, and is found in streaks and nodules in the basalt near Ashland. Some of it contains cavities lined with quartz crystals. The agate is varicolored, ranging from banded translucent gray to mottled red and yellow, and some of it contains so much iron oxide as to resemble jasper. Two specimens labeled "red moss jasper" consist of opaque and translucent chalcedony crowded full with dark-red, reddish-yellow, and yellow mosslike markings of jasper. In other specimens of moss agate there are black to dark-brown spots and dendrites. One specimen found near the town of Klamath Falls consists of rather cloudy red chalcedony or agate, inclosing streaks and spots of gray and white chalcedony.

AMETHYST.

NORTH CAROLINA.

The occurrence of amethyst at several places in the vicinity of Raleigh, N. C., has been reported at different times by L. A. Fort, of that city. An opportunity was given to the writer to examine one of these deposits on the land of George W. Partin, 5 miles northeast of Raleigh. Here amethystine quartz and pale amethyst crystals are found on the surface of a cultivated upland field. Three or four small prospect pits, now filled up, had been made a few years ago. The deepest of these pits was about 9 feet, at which depth the rock was less decomposed than near the surface and hard to excavate.

The country rock is rather fine grained biotite granite gneiss, inclosing pegmatitic seams and streaks. The granite has disintegrated to a light sandy soil at the surface and into a friable sandy saprolite to a depth of a few feet below the surface. The amethysts are found in the soil for a distance of about 150 yards in a northeast-southwest direction. Near the prospects they are very abundant, since many that were dug out had not been carried away. Probably 2 or 3 bushels of amethystine quartz crystals could have been collected in half a day from the surface of the ground. In the prospects, Mr. Fort states, the amethyst crystals were found in streaks and seams with a northeast direction, two or three parallel seams occurring within a space of a few feet.

The crystals are only moderately well developed, owing to mutual interference during growth, and nearly all have been somewhat fractured. Some of them have been only slightly chipped and others possess few if any crystal faces. The amethystine quartz and amethyst occur in pieces ranging from those of small size to those 2 or 3 inches across. Aggregates of crystals in parallel growth also occur, some of which consist of both colorless or smoky quartz and amethystine quartz. Many of the crystals are quite clear and transparent, but this is often partly concealed by etched and rough faces. The best specimens found on the surface and in the prospects had been carried off and no dark-purple amyethysts were seen. A few stones with sufficient depth of color to warrant cutting were seen, but the gems obtained would not be of the best quality. The abundance of amethystine quartz and amethyst found close to the surface at this locality invites more extended prospecting.

Mr. Fort says he has also found amethyst loose in the soil on the land of the late Capt. F. F. Ellis, 3 miles east of Raleigh.

Amethyst has also been reported from Warren County, N. C. Mr. Fort mentions a deposit on the land of Mrs. G. W. Alston, of Inez. Several years ago a prospect was opened by a clergyman at Folly Springs, near Warrenton. Some excellent crystals are said to have been found there. The principal rock of this part of Warren County is granite gneiss belonging to the same belt as that around Raleigh, nearly 50 miles southwest.

Amethyst has been found at a number of places farther west in the Piedmont Plateau region in Iredell and Lincoln Counties, N. C. A few of these are here mentioned. At some of the localities a little prospecting has been carried on and at others crystals have been found loose in the soil. In Iredell County a prospect was opened a number of years ago on the A. C. Cook place, 9 miles southeast of Statesville. A large quantity of pale amethyst and amethystine quartz crystals were found in seams and veinlets cutting coarse pegmatitic granite. Only a few stones of fairly good color were found, though many were suitable for less valuable gems. Amethystine quartz was found abundantly. A few pale amethysts have been found in the soil on the land of Mrs. M. G. Martin, about one-half mile east of the Cook place, and on Burette Brawley's place, 1½ miles south of Cook's. Maj. W. A. Graham, of Raleigh, reports an occurrence of amethyst in Lincoln County on the Erhard Forney place, 1 mile from Denver and on the Rendleman place, 2 miles from Iron Station. Good crystals of amethyst found in Lincoln County were seen in a local mineral collection at Lincolnton.

BERYL.

MASSACHUSETTS.

Aquamarine was found during 1910 at the "Beryl Hill" mine near Royalston, Mass. No systematic mining was done, but durin prospecting some excellent specimens of aquamarine were uncovered Some of this had a brilliant blue aquamarine color and cut into fin gems. One stone weighing 12 carats was sold for $100. The bes specimen was an almost perfectly clear crystal measuring about inches long, 2¼ inches wide, and three-fourths of an inch thick.

From a manuscript copy of a "Mineral lexicon of Worceste County, Mass.," by Prof. B. K. Emerson, of Amherst College, it i learned that prospecting was continued at the "Beryl Hill" min (during 1911) and a number of beautiful beryl crystals ranging i thickness from 1 inch to 2 inches were found. These crystals wer pale to true sea-green and some had the typical "blue beryl" color. The quality and brilliancy were especially fine. A few dark orange-colored beryl crystals were found also. Extensive mining was planned for 1912.

BRAZIL.

A remarkable crystal of beryl found in Brazil on March 28, 1910, has been described by George F. Kunz,[1] in a paper read before the New York Academy of Sciences on April 3, 1911. The crystal was found in a pegmatite vein in Marambaya, a village near Arassuahy, on Jequitinhonha River, in the State of Minas Geraes. It was the largest precious beryl or aquamarine crystal ever found, weighing 110.5 kilograms and measuring 48.5 centimeters high and 40 to 42 centimeters in thickness in different directions. The crystal was a simple hexagonal prism with basal planes with a few irregularities. It was so transparent that one could see through it from end to end. The color was greenish blue, and the crystal was free from included impurities. This beryl crystal was found by a Turk in what is known as a "primitive mine," at a depth of 5 or 6 meters. It was transported by canoe with great difficulty down Jequitinhonha River to the coast and shipped to Bahia, where it is said to have been sold for $25,000. It is estimated that 200,000 carats of aquamarines of various sizes could be cut from this beryl.

BOWENITE.

NEW ZEALAND.

Notes on the discovery and occurrence of a deposit of bowenite or "greenstone" in New Zealand have been given by Vice Consul General Henry D. Baker and Consul General William A. Prickitt.[2] Bowenite has been classed under serpentine in Dana's "System of mineralogy" and is stated to have a hardness of 5.5 to 6. Bowenite has been found loose in the beds of streams by the Maoris of New Zealand and, under the name "tangiwai," has been fashioned into ax heads, ornaments, and jewelry. The new locality is near Milford Sound, on the west coast of the South Island of New Zealand. A large outcrop of the bowenite has been found in a hitherto unexplored mountain region. The mineral is so massive and plentiful that it can be used for mantelpieces, table tops, and similar ornamental work. It should meet with the approval of the Chinese, by whom other forms of greenstone are held in peculiar veneration. Dr. P. Marshall, of Otago University, describes the bowenite from the new locality as unequaled in quality, and perfectly adapted for the making of ornaments, knife handles, and other purposes for which such a beautiful stone may be required. The extreme and peculiar beauty of the stone would be likely to make the demand increase enormously. Bowenite differs from nephrite (the ordinary greenstone) in its beautiful transparency, less crude color, and in hardness.

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[1] Min. and Eng. World, July 8, 1911.

[2] Daily Cons. and Trade Reports, Feb. 2, 1912, pp. 856–857.

Old Maori legends tell of the loss of the original "tangiwai" deposit in a landslide on the slopes of Anita Bay. The location of the new discovery corresponds closely with that given in the native legends. Samples brought to Auckland have been pronounced the real "queen of greenstones" by Maoris and valued above all other varieties.

Some of the bowenite is translucent in moderately thick pieces and permeated with irregular cloudy waves; the ordinary greenstone is translucent only in very thin slices. The ordinary material has sold for 12 cents a pound, but will doubtless be much less in demand and cheaper in the future.

CALIFORNITE (VESUVIANITE).

CALIFORNIA.

Occurrences of californite have been mentioned in several of these reports during the years 1901 to 1910, and detailed descriptions of some of the localities have been published as follows: In the report for 1906 notes on a deposit near Exeter, in Tulare County, were given by Frank L. Hess, of the United States Geological Survey; in the report for 1909 the prospect of C. N. White about 6 miles east of Lindsay was noted; and in the report for 1910 the original californite locality 10 miles west of north of Happy Camp, Siskiyou County, was described. Other localities are known and two of them are described below. One of these is in Butte County and has been prospected as a side issue by the North California Mining Co.; the other is in Fresno County, and at present the claims are owned by the Prethero Bros. and Nat Parker, of Visalia.

The prospect of the North California Mining Co., which has been examined by the writer, is on the west side of North Fork of Feather River about half a mile northeast of Big Bar station on the Western Pacific Railway. It is in a steep rocky hillside, almost a cliff, over 200 feet above the railroad tracks, or about 1,600 feet above sea level. The hillside has only small trees and bushes growing among the rocks and ledges. The mountains around are covered with a heavy growth of timber, among which are spruce, red fir, oak, and sugar pine. The californite was discovered about four years ago when a wagon road was graded along the hillside to facilitate the construction of the railway. Some of the mineral had been previously cut with good effects. Specimens seen in 1909 was green to white and some were nearly colorless and transparent, resembling so-called chalcedony moonstone. Some pretty apple-green and lily-green gems, showing an even quality of color and transparency, have been cut.

The californite was exposed in the roadside where a cut nearly 1 feet high had been blasted through rock. Several masses of th mineral had been broken up and removed during road constructio and the lead exposed was further prospected by a tunnel about 1 feet long driven into the hillside in a N. 70° W. direction.

The country rock consists of greenish-gray, yellowish-green, an greenish-black serpentine cut by streaks of gneissic diorite, hornblende schist, and seams of talc. The serpentine mass in which th californite occurs is over 200 yards thick and is in contact with gneissi diorite on the northeast. On the southwest, at a distance of abou 65 yards from the prospect, there is a series of gray and black slat or phyllite, quartzite, graywacke, and blue and white marble and limestone. The serpentine has been crushed to lenticular masse with many slickensided seams. The californite occurs in a belt o badly fractured serpentine some 12 feet thick with an east-wes strike and dip of about 80° N. Lenses, nodules, and streaks of californite are irregularly scattered through the gem lead. The streak range from less than an inch to several inches thick and the nodule and lenses also range from the same small size to nearly 3 feet thick One lenslike mass exposed in the tunnel was nearly 3 feet across and from it a streak 3 to 4 inches thick extended several feet to the end of the tunnel. There is a thin deposit of a hard flesh-colored minera with a granular crystalline texture between most of the californite and the serpentine.

The color of the californite ranges from bluish green or yellowish green to white and gray with a tint of pink. Pale yellowish green is the most common color, and some of this californite grades into darker green and into white or gray in the same masses. Part of the green gray, and white material is translucent and part is opaque. In some of it the color is evenly distributed through large areas, and some contains a few darker green patches and spots similar to some of the californite from the C. N. White mine, near Lindsay, in which the patches of color were shown to be caused by chromium compounds Seams and cracks or joints occur through all of the californite, so that flawless specimens of good color and quality more than 2 or 3 inches thick are rare. Many of the cracks are not sufficiently pronounced or have been recemented so that the strength of the stone has not been greatly injured and the californite can be cut regardless of them if larger pieces are desired. Larger cracks occur along some of the joint planes and form lines of easy parting or fracture in the californite.

The californite locality of the Prethero Bros. and Nat Parker is about 30 miles northeast of Sanger and 32 miles east of Fresno. It is on the east side of Watts Valley about 1½ miles south of Hawkins schoolhouse. The prospects are at elevations of about 2,000 feet above sea level, or some 700 feet above Watts Creek. The mountain side is steep and has a thin soil cover over talus and débris slopes. The principal vegetation is brushy live oak, poison oak, and stiff wirelike grass. The californite has been obtained from several prospect pits in a northwest-southeast belt. The rock formations are varied, but the californite occurs in a serpentine complex in which are chloritic and talcose soapstone phases. Fine and coarse diorite and epidotized diorite also occur near the californite deposits. Little could be seen of californite in place at the prospects visited, but it evidently occurs in lenses, streaks, and nodular segregations in the serpentine as at the Butte County locality described above. Some of the masses of californite were at least several inches thick and larger ones were probably found. Joints, cracks, and seams are numerous, and large flawless pieces are rare. The californite found here is grass-green, with a tint of yellow, lemon-green, pale yellowish green, and nearly white. It is translucent in the better specimens and much of it is evenly colored. In some of the material there are occasional darker spots or patches as in the californite described above. Considerable of the better grade from this locality has been cut by the Southwest Turquoise Co., of Los Angeles, and beautiful gems have been obtained. Stones for stick pins, brooches, cuff bottons, pendants, and necklaces cut from the grass-green or lemon-green material are extremely pretty.

The specific gravity of californite is variable. George F. Kunz[1] gives the specific gravity of the Siskiyou County californite as 3.286. F. W. Clarke and George Steiger[2] give 3.359 as the specific gravity for green vesuvianite from Fresno County, and 3.586 for compact white garnet from about the same locality. J. E. Pogue, of the National Museum, found the specific gravity of the white californite from Siskiyou County to be 3.57. Determinations made with the Jolly balance give 3.410 for green, 3.470 for pale yellowish green, and 3.599 for white californite from Butte County, and 3.351 for green californite from the deposits of Watts Valley, Fresno County. As pointed out in this report for 1910, it is difficult without an analysis to make a distinction between compact vesuvianite and compact garnet. The series of specific gravities cited indicates a gradation from one to the other, the specific gravity of californite being greater in the lighter colored varieties. Under the microscope green californite from Butte County has the low double refraction characteristic of vesuvianite and white californite from the same prospect is isotropic like garnet.

As the green and white material occur together and grade into each other both in color and in weight, the term californite should include both. In ordinary physical characters, such as hardness, toughness, luster, and fracture, the compact vesuvianite and the compact garnet are apparently identical and do not differ greatly from green and white jade. The color also of some varieties of californite is not unlike that of jade, but the material from the two localities described is rather too yellow for substitution for that mineral. Consul General S. S. Knabenshue, of Tientsin, China,[3] says, concerning a sample of california jade, that the leading firms of that city to whom it was submitted "declared that jade of this particular greenish color has no commercial value in the Chinese market. The jade which is most esteemed is semitransparent, of a clear emerald-green. Next to this white jade stands in greatest favor. The color seems to be the point most insisted on." It is probable that this statement was made in regard to californite from the North California Mining Co.'s property, since that company received a similar reply concerning a sample sent to China in search of a market. It seems that the choice of the Chinese does not rule out white californite and such material should be submitted to Chinese merchants for valuation. This has been found in some quantity in Siskiyou County and Butte County, and some it contains a few emerald-green spots. The green californite fro Siskiyou County is not greatly different in color from jade used fo earrings by the Chinese and is mottled with similar patches of gree

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[1] Gems, jewelers' materials, and ornamental stones of California: Bull. California State Min. Bur. No. 37, 1905, pp. 93–95.

[2] On californite: Bull. U. S. Geol. Survey No. 262, 1905, pp. 72–75.

[3] Daily Cons. and Trade Repts., Oct. 25, 1911.

CHRYSOPRASE.

CALIFORNIA.

In the description of the chrysoprase deposits of Tulare County Cal., in this report for 1909, a prospect of the Himalaya Mining Co near Lindsay was mentioned in connection with the notes on tha company's mine, three-fourths of a mile north of town. This prospect was examined in 1911. It is in the top of a low hill about mile S. 70° E. of Lindsay. The hill is about one-third of a mile lon in a N. 25° W. direction. It rises about 60 feet above the plains a the ends and is lower in the middle. Several small prospect pits an trenches had been made, chiefly at the north end of the hill, but littl gem chrysoprase was found. The occurrence is similar to that o the other deposits. Jaspery and cherty serpentine heavily staine with yellow and red iron oxides outcrops along each end of the hil in rough ledges and masses. Fine-grained diorite forms the wes central portion of the hill. The jaspery serpentine is cut in man directions by seams and veinlets of chalcedony and fine-grained chalcedonic quartz, ranging from paper thickness to 2 or 3 inches thick In some of these veinlets there was a slight tint of green, but n chrysoprase was observed. Veinlets of greenish and yellowish-gree opal are also plentiful through the jaspery serpentine.

The production of chrysoprase in 1911 came from the mine of th Himalaya Mining Co., 8 miles southeast of Porterville, and from som of the deposits on Venice Hill, 8 miles east of Visalia. Some high-grade gem material was obtained at each locality. A quantity o low-grade chrysoprase and some chrysopal are obtained during mining. These are generally shipped to Germany for cutting.

ARIZONA.

The occurrence of chrysoprase about 20 miles west of Mineral Park in Mohave County, Ariz., was mentioned in this report for 1908. Th deposits are owned by John L. Riggs and Walker Bros., of Chloride The occurrence is quite different from the California localities. Specimens sent by Mr. Riggs were decomposed fine-grained rhyolite porphyry with small quartz phenocrysts and perlitic volcanic glas country rock. Associated minerals of the chrysoprase were black flint, red and brown jasper, gray and white chalcedony, and quartz. Some of the specimens were brecciated and contained fragments o chrysoprase. So far high-grade gem material has not been found, but the brecciated matrix containing chrysoprase would furnish unusual and attractive gems for the tourist and souvenir trade. Large lumps of rather granular opaque chrysoprase have been found which could be cut into small ornaments.

The so-called "blue chrysoprase," or copper-stained chalcedony, from the Keystone and Live Oak copper mines near Miami, Ariz., was described in this report for 1909. Very little of this material is now obtained from the mines, as the workings have been carried below the levels in which it occurred. The small quantity now cut probably comes from stocks set aside while those parts of the mines were being worked, and from random lots still obtained by "jay-hawkers" from old stopes.

DIAMOND.

ARKANSAS.

Conditions in the Arkansas diamond region of Pike County have been briefly summed up by John T. Fuller.[1] Prospecting during the last five years has demonstrated two diamond-bearing pipes. Washing to date on the original area of discovery has yielded 28 carats of diamonds per 100 loads of 16 cubic feet of earth washed. Little development was done in 1911 through lack of capital. The most important find of the year was an $8\frac{1}{2}$-carat white diamond on the Mauney tract, a portion of the original pipe. This is the largest diamond so far found in Arkansas. Another white diamond of $3\frac{44}{64}$ carats was found on the property of the American Diamond Mining Co. It is also the largest stone yet found on this property.

The Arkansas Diamond Co. reports that its mine was not operated during 1911, but that a small amount of washing was done resulting in the recovery of 155 stones weighing $45\frac{5}{8}$ carats. Press reports of the discovery of a big diamond in the Mauney mine[2] place its weight at 10 to 14 carats, one of the articles stating that the stone had not been weighed at that time. The diamond is described as "blue-white, apparently flawless, and wedge shaped." No information about the stone was given to the Survey by Mr. Mauney, but it is doubtless the same stone whose weight is given as $8\frac{1}{2}$ carats by Mr. Fuller. In a communication received from the secretary of the American Diamond Mining Co., a diamond weighing $2\frac{44}{64}$ carats is reported to have been found on the company's property by Mr. Reece Lamb, vice president. This stone has been valued at $165 per carat and might lose 40 per cent in cutting. It is doubtless the same stone referred to by Mr. Fuller as weighing $3\frac{44}{64}$ carats.

CALIFORNIA.

Mr. M. J. Cooney reports that three small diamonds were found in the Cherokee Flats region, Butte County, Cal., during 1911. These stones were obtained by placer miners, washing for gold in the same way that all the diamonds of that region have been found. One of these stones of one-fourth carat weight is said to have come from ground owned by the United States Diamond Mining Co., of which Mr. Cooney is president.

TEXAS.

Attention was called by Mr. T. E. Willson, editor of the Jewelers' Circular Weekly, to a reported discovery of diamond in Texas, and further information furnished by correspondents was given. The Geological Survey has not examined the locality. The discovery is claimed by Fred. W. Packer in Montgomery County, Tex., who states that he noticed the resemblance of certain formations of Montgomery County to those of the South African diamond mines and commenced prospecting. A badly flawed diamond weighing 2¼ carats is reported to have been found and indications are that more thorough prospecting will be done. A stone reported to have come from Montgomery County was shown to the Sweeney Jewelry Co., of Houston, Tex., and was pronounced diamond. In a communication to the United States Geological Survey Mr. Packer states that the diamond was found 4 miles north of Montgomery and weighed 3½ carats.

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[1] Eng. and Min. Jour., Jan. 6, 1912, p. 6.

[2] Jewelers' Circular Weekly, June 21 and June 28, 1911.

ILLINOIS.

A discovery of diamond has been reported in Jefferson County, Ill. Mr. Austin Q. Millar, of St. Louis, informed Dr. F. W. De Wolf, of the State Geological Survey of Illinois, in a letter dated February 9, 1912, that a man had displayed 22 diamonds to the Eisenstadt Manufacturing Co., of St. Louis. The largest of these stones weighed 7¼ carats. Mr. Eisenstadt, of the Eisenstadt Manufacturing Co., informed the writer that the stones were genuine and were reported to have come from the vicinity of Macomb, Ill., by C. L. Goulding, a jeweler of Alton, Ill. A press report [1] gives the locality as the farm of Matthew Fox, near Ashley, and states that the stone weighed 7¾ carats and would yield a gem worth about $225. A letter from Mr. Fox to the writer, dated Wood River, Ill., April 29, 1912, gives the following information: The diamond was found in Jefferson County about a year ago on the farm of T. H. Bledsoe, about 3½ miles east of Ashley. It was found on a sloping piece of ground in the gravelly soil of a cornfield a few yards from a stream. It weighed 7 carats and was purchased by a firm in Alton for $175.

AFRICA.

UNION OF SOUTH AFRICA.

Cape Colony.—The output of diamonds during the fiscal year 1911 by the De Beers Consolidated Mines [2] amounted to 2,180,856 carats, valued at £4,938,087, as compared with 2,416,666 carats, valued at £5,414,896, in 1910. The total production of blue ground in 1911 amounted to 8,105,138 loads, as compared with 5,111,524 loads in 1910. The total amount of blue ground washed was 9,219,192 loads, as compared with 8,531,090 loads in 1910. The stock of blue ground and lumps on the floors was increased from 7,776,059 loads in 1910 to 9,021,026 loads in 1911. The De Beers mine has not been reopened since it was closed in 1908. The surface equipment is being remodeled. Blue ground from the depositing floors of all the mines was washed. The yield in carats of diamonds per load of blue ground washed decreased from 0.38 to 0.28 at the De Beers and Kimberly mines, from 0.32 to 0.27 at the Wesselton mine, and from 0.23 to 0.21 at the Dutoitspan mine. The yield per load of blue ground washed increased from 0.37 to 0.38 carat at the Bultfontein mine.

Transvaal.[3]—The production of diamonds in Transvaal during the fiscal year ending June 30, 1910, amounted to 2,098,528 carats, valued at £1,317,479—an increase of 169,036 carats in quantity and of

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[1] Jewelers' Circular Weekly, Apr. 17, 1912.
[2] Twenty-third Ann. Rept. De Beers Consolidated Mines, for year ending June 30, 1911.
[3] Ann. Rept. Govt. Min. Eng., Transvaal, 1910.

£22,183 in value over 1909. The Premier diamond mine continues to be the principal producer, but several other mines and the alluvial diggings at Christiana contributed to the output.

Orange Free State.[1]—The total production of diamonds in the Orange Free State (formerly Orange River Colony) during the fiscal year ending June 30, 1910, amounted to 787,614 carats, valued at £1,525,707, as compared with 654,319 carats, valued at £1,048,607, in 1909. The principal output came from the Jagersfontein, Koffyfontein, Voorspoed, Roberts, Victor, and a few other mines, but the alluvial diggings along Vaal River contributed 1,653 carats, valued at £6,983. At the mines 8,027,487 loads of blue ground were washed, yielding 10.19 carats of diamonds per 100 loads of ground. The yield per 100 loads washed was less than in 1909, but the average value obtained per carat was greater. The value of the diamonds from the alluvial diggings averaged more than twice as much as those from the mines. Among the largest diamonds found in the alluvial diggings was one of 38 carats, valued at £250, and another of 24 carats, valued at £272.

BELGIAN KONGO.

The discovery and occurrence of diamonds in Belgian Kongo has been described by Sydney H. Ball.[2] A few stones were found both in the tributaries of Lualaba River, and in that river itself by prospectors of the Tanganyika Concessions Co. during the years 1906 to 1910. These diamonds were found in gravels and the concentrates with which they were associated contain garnet, diopside, diallage, biotite phlogopite, olivine, zircon, wollastonite, aragonite, calcite, and goyazite. A rock similar to kimberlite is reported to occur in the Kundelungu Plateau, east of the diamond localities, cutting red sandstones of "Permo-Carboniferous" age.

In 1906 American and Belgian capitalists took over a mining concession in Belgian Kongo under the name Société internationale forestière et minière du Congo. One small diamond of fine quality was found by a prospector near Mai Munene in Kasai River. Work was recommenced in 1911 and many diamonds were found. At one place, about 55 miles northwest of Mai Munene 240 stones were found in two weeks by one man. So far diamonds have been found for a distance of about 75 miles along Kasai River, and in the lower parts of its tributaries. They occur in riffles or potholes in the river bed or in sands along their banks and are locally abundant. Some of the gravel has a rather weak limonite cement. The majority of the stones are well crystallized. The common forms are octahedrons with some dodecahedrons and a few trisoctahedrons. Curved faces, etching, and twinned crystals are common. A large percentage of the stones are white, the others are mostly yellow and off-color, but some deep-yellow, topaz, and apple-green stones occur. Associated minerals are gold, quartz, cyanite, magnetite, zircon, ilmenite, feldspar, mica, garnet, epidote, rutile, and hematite, in addition to carnelian, chalcedony, agate, jasper, chert, diorite, schist, and granite pebbles.

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[1] Seventh Ann. Rept. Mines Dept. Orange Free State, 1910.

[2] Eng. and Min. Jour., Feb. 3, 1912.

The basement rocks of the region are micaceous schists, quartzite, granitic, and basic igneous gneisses intruded by granites, diabases, and gabbros. They are older than "Permo-carboniferous" and are probably of pre-Cambrian age. On this basement series "Jura-triassic" sandstones and shales were deposited. These sandstones and shales now form a blanket over the central basin of Kongo River. The deeper streams have cut through them to the basement rocks, and it is in such a stretch of Kasai River that diamonds have been found. The diamonds may have originated from one of the basic igneous rocks of the older series, or have formed pebbles in the sandstones. It is thought to be more probable they will be found in basic intrusive masses cutting "Jura-triassic" sandstone. It is interesting to note that these beds are the stratigraphic equivalent of the youngest sedimentary rocks cut by the kimberlite of South Africa.

GERMAN SOUTHWEST AFRICA.

According to Consul General T. St. John Gaffney,[1] the diamond fields in German Southwest Africa have not come up to expectations after five years of development. The dividends paid by the Colonial Mining Co., the Kolmanskop Society, and the German Diamond Society have fallen off considerably and the Lüderitzbucht combined companies paid no dividends in 1910. Difficulties reported are the exhaustion of the rich supply of the surface diamonds, requiring more costly mining methods, a shortage of labor, and an export tax of 33⅓ per cent of the gross value of the diamonds.

NOTES ON DIAMOND.

Larger diamonds of South Africa.—L. J. Spencer[2] has given a list of 26 of the larger diamonds of South Africa, with their weights, the number of stones cut from many of them, etc. Twenty-five of these diamonds weighed over 100 carats each, and nine of them yielded single cut gems of over 100 carats weight. Of 13 of the diamonds the yield of cut gems ranged from 34¼ to 59 per cent. Among the diamonds mentioned are the Cullinan, Excelsior, Jubilee, Imperial, Tiffany yellow, and Star of South Africa. Errors and uncertainties concerning the weight of some of the stones are corrected and adjusted, thus: The Excelsior diamond is shown to have weighed 969½ carats, the Jubilee 634 carats, and the Imperial approximately 456⅘ carats.

Metric carat.—In the article mentioned Spencer calls attention to the difficulty of getting the correct weight of many gems, especially of those of international interest, when a standard weight of measure is not used and when the word "carat" means something different in different countries. The simplicity of the metric carat of 200 milligrams as a substitute for the variable carat weight of many countries is made evident. The metric carat is 5.304 milligrams lighter than the English carat. It has been legalized in Bulgaria, Denmark, France, Germany, Holland, Japan, Norway, Portugal, Roumania, Spain, Sweden, and Switzerland. The metric carat became official in Germany[3] on April 1, 1911, and should be adopted by all countries for simplicity and convenience.

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[1] Daily Cons. and Trade Repts., Sept. 6, 1911.

[2] Mineralog. Mag., vol. 16, October, 1911, pp. 140-148.

[3] Jewelers' Circular Weekly, Apr. 17, 1912.

EMERALD.

NORTH CAROLINA.

Emerald is ranked among the few really precious stones and by some people is considered the most valuable. It has been prized from early times because of its beauty and rarity. The number of localities where good gems have been found is few, and some of those once known have been forgotten. The following notes on foreign localities are taken from a book by Max Bauer.[1] Emeralds found with the mummies of Egypt probably came from the mountains along the west coast of the Red Sea in Upper Egypt, where ancient workings were discovered during the nineteenth century. Mines in the Salzburg Alps are said to have been worked intermittently for emeralds since the time of the Romans to the present. The world's principal supply of emeralds has come from South America. They were first brought to Europe from Peru by the Spaniards in the sixteenth century. None are now found in that country, and it is thought that the Peruvians obtained them from Colombia. Three mines were worked by the Spaniards in Colombia. Later two of these were lost, and for many years the only mines worked were those near Muzo. Recently the lost mines of Somondoco were found on the east side of the Andes Mountains at an elevation of about 9,000 feet above sea level.

Fine emeralds have been found in the Ural Mountains about 60 miles east of Ekaterinburg. This locality was discovered in 1830 by a peasant, who noticed the stones among the roots of a tree torn up by the wind. A few other European localities are known. Emeralds have been found at two localities in Australia. The most promising one is near the township of Emmaville in New South Wales.

Several localities in the United States have yielded emeralds, but the best specimens have come from North Carolina. In Maine a few stones have been found at Topsham and a pale-colored stone at Newry. A few crystals are reported to have been found at Haddam, Conn.

In North Carolina three localities are now known where good emeralds occur. The first of these to be discovered was in Alexander County in 1875 by J. A. D. Stephenson, of Statesville, N. C. This locality was later developed into the emerald-hiddenite mine near the present railroad station, Hiddenite. The second locality was discovered in 1894 by J. L. Rorison and D. A. Bowman on Crabtree Mountain in Mitchell County. Both of these deposits were developed on a fairly large scale and a few fine gems were obtained from each. Progress at the third emerald locality described below has been given in these reports for 1909 and 1910. The deposit is on the land of W. B. Turner, 4¾ miles S. 30° W. of Shelby, near the east bank of First Broad River, in Cleveland County. Some 15 years ago two emeralds were found loose in the soil on the Borders farm about 1 mile east of Mr. Turner's. Further search failed to discover more gems and prospecting was given up. Subsequent investigation indicates that these stones were transported by residents or farm hands on the Turner plantation to the adjoining place during friendly intercourse of long standing.

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[1] Precious stones [translation by L. J. Spencer]; Charles Griffin & Co., Ltd., London, 1904, pp. 309 et seq.

The attention of the writer was called to the discovery on the Turner place by Mr. George L. English, of Shelby, to whom acknowledgment is due for many courtesies and much information. The first visit to the prospect was made in December, 1909, at which time no digging had been done, but about a dozen emeralds had been found loose in the soil of a cotton field. The locality is in a rather roughly dissected portion of the Piedmont Plateau, such as is generally found along the larger creeks and rivers. The elevation is about 680 feet above sea level, or about 30 feet higher than First Broad River near by. The higher ridges of the Piedmont Plateau in the neighboring country are about 800 to 850 feet above sea level. The crystals have come from an area of about 100 feet by 25 feet on a hillside of moderate slope to the northwest. The slope is toward the river on the west about 150 yards and toward a small stream entering the river from the northeast. The field in which the emeralds were found had been cultivated and they were exposed by plowing and by the washing of rains.

Prospecting up to December, 1911, consisted of the digging of several pits and trenches, some of which had been filled up. The largest working was a crosscut trench over 100 feet long and from 2 14 feet deep. This work was done by Mr. Turner and Mr. English during 1909, 1910, and the first part of 1911. The property was optioned and leased by Lovat Fraser, of New York, and prospected during the last part of 1911 and the first part of 1912. In the spring of 1912 it was purchased by Messrs. Fraser and E. P. Earle, of New York, and will be extensively prospected. Excavations have been carried deeper by Mr. Fraser than when last examined by the writer. Promising finds of emeralds have been made at each working, but these discoveries have been followed by periods of uncertainty as to the continuity of the vein.

The crystals found loose in the cotton field had a fine dark-green color, but were somewhat checked and flawed, and some contained silky internal markings. The largest of these emeralds and the best specimen so far found measured about 1 inch by three-fourths of an inch by half an inch. It was about half of a crystal split parallel with the length. This piece has been cut into about 20 gems, the largest of which is a faceted stone weighing about 3 carats. This stone has been described as having an excellent deep-green color and as being particularly beautiful at night. It has almost no visible flaws but is slightly foggy in strong daylight. The other gems cut from this crystal are of similar quality, but some contain more flaws. The other stones found on the surface ranged down to less than a carat in weight in the rough and most of them were deep green. Some were nearly whole crystals and others were fragments of crystals. All were rather strongly etched and striated. Very pretty gems have been cut from smaller fragments of crystals found on the surface. Some of these were sold at rather low prices before their true value was realized and the proceeds were devoted to prospecting. These gems brought $10 to $30 per carat. A lot of 11 of these emeralds cut "en cabochon," weighing about 9 carats, have been mounted in a small necklace and would bring several hundred dollars at retail prices.

Gems cut from emeralds removed from the vein have also proved of good quality but are probably not quite so deep in color as those found on the surface. The crystals from the vein range in size from that of a portion of a large needle to a broken specimen measuring seven-eighths of an inch thick and nearly 5 inches long. Some of these emeralds have fairly well developed crystal faces, but the majority are roughly striated and pitted, though retaining a rude hexagonal outline. In some specimens no trace of crystal form remains. As usual with emeralds, only small pieces are free of flaws and imperfections. Many crystals contain slight checks across their length, and in some the flaws lie at all angles. Some stones are cloudy and others contain fine internal striations or silkiness. Stones in which this is pronounced give a fine cat's-eye effect when tipped to and fro. Small crystals have been found that will cut practically flawless stones up to one-half carat in weight, and even in such small gems a flawless emerald of good color is very rare. The quality of many of the emeralds can not be judged from their external appearance, as the exterior is badly striated and by reflection of the light makes the stone appear both of lighter color and more imperfect than it really is. The average of the emeralds from the Turner mine has been pronounced equal in quality to the average run of Colombian emeralds, and New York dealers are beginning to recognize the beauty of the North Carolina gem.

Mr. Fraser has furnished an estimate of the total quantity of emeralds obtained from the Turner mine along with notes on a few of the gems cut from vein material. The exact weight could not be given, as some of the stones were cut and sold before the property came into his charge. In all about 2,700 carats of rough stones have been found. So far over 200 carats of gems have been cut and to judge from the yield in cutting, about 700 carats of cut gems ought to be obtained from the 2,700 carats of rough material. From the rough material selected as fit to cut, the yield of gems has been about one-third. The cut gems have been valued at $5 to $200 per carat wholesale, and a moderate estimate of the average value would be $15 per carat.

One lot of 27 cut stones ranging up to over a carat in weight, seen by the writer, contained some fine stones. One of these with a table cut, weighing 0.83 carat, was a fine, clear, dark-green gem with only a slight flaw. This stone has been variously estimated by lapidaries and dealers as worth from $125 to $200. Reputable lapidaries valued it at about $200 per carat. Other stones in this lot are worth up to $90 per carat, but some would probably not bring over $10 to $25 per carat. Mr. Fraser mentions a lot of smaller gems, chiefly about one-fourth of a carat in weight, but some at least half a carat, which are "brilliant, very clear and clean, and of good green color." One oblong faceted stone of about 1 carat has a good color, is clear, and is not badly flawed. It is considered one of the best gems found. Another fairly clear and fairly brilliant gem weighing 2¼ carats and having a good color has been classed by a lapidary as one of the most important gems. An attractive gem is a long tapering drop weighing 20 carats. It has an excellent color and is clear in spots.

Before taking up the discussion of the geologic occurrence of the emerald a few notes on its nature and modes of occurrence at other localities will be given for comparison with the new locality.

Emerald is a variety of the mineral beryl. Beryl is a silicate of aluminum and beryllium containing a small per cent of water. Small quantities of other elements may be present and in some stones influence the color. Thus, beryl containing cæsium is generally colorless and very brilliant; the presence of lithium produces the pink beryl, and chromium the emerald. Other color varieties of beryl are aquamarine, blue beryl, and golden beryl. A small per cent of chromium oxide is sufficient to impart a rich emerald-green to beryl. According to Bauer,[1] an analysis by F. Wöhler of Colombian emerald gave 0.186 per cent chromium oxide.

Beryl crystallizes in the hexagonal system and commonly occurs in six-sided prismatic crystals terminated by the base with or without other faces. In emerald simply the prism faces and base are the most common. Beryl is nearly always found crystallized, even when "frozen" in hard rock. Crystals that have developed in cavities are in some cases beautifully developed.

The following notes on the occurrence of emeralds in Colombia, Egypt, the Ural Mountains, and Salzburg Alps are taken from Max Bauer.[1]

In Colombia emeralds occur in calcite veins and nests in dark bituminous limestone. The limestone overlies red sandstone and clay slate of Cretaceous age. The calcite may be dark with bituminous matter or clear like Iceland spar. Associated with the emeralds are fine quartz crystals, both colorless and green, pyrite, green gypsum, black dolomite, and parisite, a fluo-carbonate of cerium, and other rare metals. In Upper Egypt the emeralds occur in dark mica schist interfoliated with talc schist, and at one locality these rocks contain also augite and hornblende. The occurrence in the Ural Mountains is said to be very similar. In the Salzburg Alps the matrix is described as somewhat similar and consists of finely granular dark brown and greenish mica schist interfoliated with chlorite and hornblende schist.

The emeralds found in Maine and Connecticut were associated with pegmatite.

At the emerald-hiddenite mine in Alexander County, N. C., emeralds have been found in pockets and cavities in veins cutting biotite gneiss. The gneiss has been strongly compressed and folded while in a plastic condition. In the neighborhood of the veins it has been highly silicified by the addition of much quartz which, along with muscovite, rutile, pyrite, etc., has replaced the biotite and feldspar. The minerals filling the veins are quartz, calcite, dolomite, muscovite, rutile, black tourmaline, pyrite, chalcopyrite, monazite, aquamarine, emerald, and hiddenite. There are numerous veins near the mine which carry common beryl, aquamarine, and quartz, but emeralds and hiddenite were found in only a few veins. Hiddenite, the emerald-green spodumene, was the chief mineral of value obtained from this locality, though some fine emerald crystals were found.

According to Arthur Keith,[2] at the Crabtree Mountain locality in Mitchell County, N. C., the emeralds occur in pegmatite inclosed in mica gneiss. A few feet east of the vein is a body of hornblende gneiss. The pegmatite has a northerly strike and dips 45°–50° E. It is composed mainly of feldspar, quartz, black tourmaline, and beryl, and incloses horses of biotite-tourmaline schist. The emeralds occur sparingly through the pegmatite but are more plentiful in the upper 8 inches under the hanging wall where many are in small bunches and horses of schist. The gems are "frozen" in the pegmatite. Small crystals of emerald are abundant, and the color of many of them is good emerald-green. Some are pale colored or yellowish. Occasional gems of value have been found. Much of the pegmatite matrix containing white feldspar, gray quartz, black tourmaline, and green emeralds, has been cut under the name of emerald matrix. Some of this materail is very pretty.

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[1] Precious stones (translation by L. J. Spencer), Charles Griffin & Co., Ltd., London, 1904.
[2] Mount Mitchell folio (No. 124), Geol. Atlas U. S., U. S. Geol. Survey, 1905.

The occurrence of emeralds at the Turner mine is similar in many respects to that at some other localities, but there are here certain associated rocks which seem to belong naturally with the occurrence of emeralds that are not present in other deposits.

The rocks of this portion of the Piedmont Plateau are principally gneisses and schists of Archean age, cut by masses of later granite, diorite, and other rocks. In the region around the emerald prospect the types of rock are varied. There are mica, garnet, cyanite, graphite, and hornblende gneisses and schists cut by granite, pegmatite, diorite, gabbro, and other ferromagnesian rocks. Another rock which answers the description of garnetiferous quartz diorite occurs abundantly at certain horizons in the gneiss. The strike of the rock formations is variable between east-west and north-south where the strata are tilted, but over large areas they are essentially flat with many small rather gentle folds.

Warping of the rocks with larger sharp folds occurs and produces abrupt changes in outcrop, so that mapping the formations is difficult. Another difficulty is the apparent metamorphism of ferromagnesian rocks to rocks of less basic composition, and of granite to more basic composition by reaction between the two at the time of the intrusion of the granite. In the descriptions of the rocks associated with the emerald deposit in these reports for 1909 and 1910, tentative names were given to some rocks, as the material available for examination was so badly weathered. Less altered specimens obtained from greater depth have made more accurate determinations possible. Thus, rock called amphibolite, and amphibolite after pyroxenite, proves to be hornblende hypersthenite and is so called below. A number of varieties of basic rocks occur, but all may be placed in one general class.

The most common type is hornblende hypersthenite-peridotite, and of this there are numerous outcrops. In some occurrences olivine is lacking or scarce, and the rock may be called hornblende hypersthenite. The minerals composing these rocks, as determined by microscopic examination, are pale-green hornblende, light-brownish hypersthene, olivine, augite, biotite, pleonaste, magnetite, and a little sulphide. Hornblende and hypersthene are present in all occurrences, but one or all of olivine, augite, biotite, and pleonaste were not observed in some specimens. The hypersthene and olivine occur in poikilitic crystals, in some specimens of large size. In some places weathering has changed hypersthene to bastite, hornblende to chlorite, and added limonite stains. The result is a rock resembling chloritic soapstone. On disintegration and decomposition these rocks break down to a dark greenish-brown lumpy soil.

Gabbro occurs at several localities and is of two kinds, common and olivine gabbro. The former exhibits a partial diabasic texture in thin section. The constituent minerals determined microscopically in on specimen are labradorite, hornblende, part original and part forme from pyroxene, augite, hypersthene, biotite, magnetite, apatite, an pyrrhotite. Olivine gabbro is associated with the hornblend hypersthenite-peridotite, and the two rocks are probably segregations from the same magma. Some specimens contain such mineral as to make it difficult to determine whether the rock should be calle olivine gabbro or hornblende hypersthenite-peridotite. The olivin gabbro weathers to a soil very similar to that formed by the peridotite. Spheroidal bowlders are generally left over in the outcrops.

Diorite and hornblende gneiss are common rocks of the region Microscopic examination of sections reveal hornblende, andesine biotite, iron ore, apatite, zircon, and, in some specimens, quartz. On weathering the dioritic rocks form dark-brown clay soils.

The granite of this region is medium-grained biotite granite. Pegmatitic phases are associated with it, especially near the contact with other rocks, and in some places the small bodies may equally be called pegmatite or granite. On disintegration the granite breaks down to a light sandy soil.

The relations between the granite and the basic rocks are interesting. Besides the types of basic rocks mentioned, there are gradations from them into granite by the presence of granite minerals. This gradation is present where gabbro, olivine gabbro, and hypersthenite-peridotite are inclosed in granite. Thus, a specimen from a spheroidal bowlder of weathering near a gabbro and granite contact contained andesine or labradorite, hornblende after pyroxene, biotite, and considerable quartz along with iron ore, apatite, and pyrrhotite. The true gabbro from this body has more calcic feldspar and ferromagnesian minerals with no quartz. A spheroidal bowlder from a similar contact at the emerald mine contained hornblende, biotite, labradorite, quartz, magnetite, and apatite. Diorite contacts with granite show a similar gradation by the presence of quartz.

The ages of all the different rocks have not been determined. The mica and garnet gneisses and schists are of Archean age and belong to the Carolina gneiss, as designated by Keith in the geologic folios on the southern Appalachian region. The diorite and associated hornblende gneiss and schist are also Archean and belong to the Roan gneiss. The gabbro, olivine gabbro, and hornblende hypersthenite-peridotite rocks are probably of later age. They were intruded into the other gneisses and schist before the granite, and Keith thinks much of the granite of this region is probably of post-Carboniferous age. The intrusion of the granite before the complete consolidation of the basic rock magmas would make easier an explanation of the apparent mutual absorption described above that has taken place between the two. If the basic rocks are considered much older than the granite, the reaction between the two and absorption by the granite appear to offer a better explanation than would be offered by magmatic differentiation.

Pegmatite probably representing later stages of activity of the granite magmas have filled openings and fissures in the rocks. Some of these are in the basic rocks, and it is in such fillings that the emeralds have been found on the Turner place. Several pegmatite veins have been uncovered during the prospecting, but so far emeralds have been found in only one of them. The basic rocks are olivine gabbro and hornblende hypersthenite, with transitional phases between them. Diorite lies to the west of these, and all have been surrounded and intruded by biotite granite.

The emerald-bearing vein has an irregular strike approximating east and west with a high dip north. It is medium to coarse grained, and is composed of quartz and feldspar, part of which, at least, is albite, with some black tourmaline sprinkled through it and an occasional emerald or green beryl crystal. The crystallization of the minerals of the pegmatite is not good, but a few partly developed crystals are found in small, irregular miarolitic cavities. Crystals found in these cavities are quartz (colorless and smoky), albite, feldspar, black tourmaline, and a little beryl. The cavities in the pegmatite are partly filled with reddish-brown, greasy-feeling clay, and the same material along with limonite stains has permeated joints and seams through the pegmatite. The feldspar of the pegmatite has partly decomposed in places, so that the rock breaks down rather easily. Some of the emerald crystals are firmly attached to other minerals, and some are loose and may be obtained by washing the semidecomposed pegmatite. At first many small fragments and crystals of emeralds were found in this way, but later gem emerald was also found in place in the rock.

The crystallization of the quartz and feldspar so far found in the pegmatite vein is not so perfect as that in the veins once worked for beryl and hiddenite at Hiddenite, N. C. The albite assumes the form of rough crystals and of aggregations of stout crystals, though not of the clevelandite type common in many gem-bearing pegmatites. The quartz occurs in crystals of average perfection, and in many of the specimens exhibits trapezohedral faces indicating a right-hand character. Some of the quartz is nearly colorless and other is smoky. One crystal of quartz examined is penetrated by numerous fine light-colored needles of actinolite. The emerald crystals are simple hexagonal crystals of beryl with the prism faces and base. Many of them are deeply striated and etched, especially on the prism faces. Other crystals have internal striations or irregularly shaped tubes extending through their length. Some of these tubes are of considerable size compared with the crystal inclosing them and have been filled with clay or iron stains. The finer tubes appear as silky striations in the crystals.

Veins containing quartz crystals occur in the same formation as the emerald-bearing pegmatite. Some of the quartz crystals from these veins are fairly well developed and clear; others contain inclusions of fine needles of actinolite and cut into very pretty gems. Veins of quartz crystals occur over a large area in this region and yield some fine specimens. Large crystals containing liquid with bubbles have been found about a mile northwest of the emerald mine in a similar rock formation. Black tourmaline is plentiful both at the emerald mine and in other places.

Determinations of chromium oxide were made in four rocks from the emerald regiom by R. C. Wells, of the United States Geological Survey. Hornblende hypersthenite wall rock for the emerald vein carried 0.16 per cent Cr_2O_3; olivine gabbro, also close to the emerald vein, contained 0.17 per cent Cr_2O_3; hornblende-hypersthene-augite peridotite from about three-fourths of a mile east of north of the emerald mine carried 0.19 per cent Cr_2O_3; and diorite from near the emerald mine carried 0.04 per cent Cr_2O_3.

Pale-greenish, yellowish, and gray beryl crystals have been found in pegmatite cutting granite and mica schist and gneiss in this region, but the only emerald deposit discovered is where such pegmatite cuts a chromium-bearing rock. This association of emerald-bearing pegmatite with a chromiferous basic rock seems a most natural one. A theory of origin of the emeralds at the Turner mine may be thus briefly stated:

Chromium-bearing basic rock was intruded by granite magma either before or after final solidification of the basic rock. There was a partial absorption of the latter by the granite magma and some of the constituents of the basic rock were taken into solution. Pegmatite veins, in which distinct crystals were only partly developed, formed during the cooling of the rocks. The elements necessary for the formation of beryl were present in the magmatic solutions producing pegmatite, as in some other places in the region. Chromium oxide necessary to impart a color to the emerald was obtained by the action of solutions on the basic rock. A curious coincidence is the fact that the per cent of Cr_2O_3 in the basic rocks at the Turner mine is about the same as that found in emerald from Colombia, by T. Wöhler, as mentioned above.

Should the theory of origin outlined above be essentially correct, prospecting in areas where similar rock associations occur might locate other deposits of emeralds. Of course, it should not be expected that every pegmatite associated with the rocks mentioned will carry emerald, for beryl has been found with only a very small proportion of the large number of pegmatites occurring in the region. Besides chromium-bearing basic rock and pegmatite, the presence of the elements of beryl in the original pegmatite-producing solutions would be necessary. Outcrops of basic rocks similar to those at the Turner mine occur in a number of localities in the region south of Shelby, and some of these are near if not associated with granite. Pegmatites cut many of these basic rock masses, and over some of the outcrops crystals of black tourmaline, quartz, and quartz-inclosing actinolite are plentiful as at the Turner mine. In some of these areas the associations are very similar to the emerald locality. The occurrence of the basic rocks is not always easily recognized, since weathering has been extensive. In such places a study of the soil will often give the clue desired.

GARNET.

NEW HAMPSHIRE.

The occurrence of a quantity of deep-red garnets on a hill near Chesham, in Cheshire County, is reported by Mr. Leon Allen, of Keene, N. H. The garnets are small but would yield clear gems ranging from one-eighth to one-half of a carat. Further prospecting will be carried on during 1912.

COLORADO.

The discovery of small bright-yellow grossularite garnets is reported by Mr. J. D. Endicott, of Canon City, Colo., in the basin of North

Fork of Arkansas River. These garnets occur in cavities in altered granitic rock and make good specimens. They are of gem quality, but too small for cutting. Mr. Endicott also obtained a quantity of specimens of spessartite garnet from the "Ruby Mountain" locality across Arkansas River from Nathrop. These garnets occur in cavities in rhyolite associated with topaz and other minerals. The topaz also occurs in good crystals and makes fine specimens.

JASPER.

MONTANA.

Specimens of Montana jasper have been furnished by Mr. J. H. Mosher, of Glendive. One variety is composed of dark-yellow jasper, in which are turtle-back markings of gray chalcedony and a little metallic hematite with a few patches of bright-red jasper scattered through the specimen and in a broad band along one side of it. The pattern and colors displayed by a gem cut from this material are very pretty. Another variety which Mr. Mosher calls mahogany jasper has a dark-reddish mahogany color with peculiar patches and irregular streaks of darker color resembling the grain of wood.

CALIFORNIA.

The spherulitic jasper-like quartz from the San Francisco region described in this report for 1910 is being cut with good results. The trade name "kinradite" was proposed in acknowledgment of Mr. J. J. Kinrade's part in bringing this unique gem before the public. There is considerable variation in color and size of markings in different specimens, but the beautiful radial structure of the red spherulites is visible in most gems. Probably the most common type of stone consists of bright-red spherulites in dark-greenish and reddish-brown matrix. An attractive stone is cut from material in which the red spherulites are scattered through an ocher-yellow matrix. Mr. Kinrade says the best specimens are found between Point Bonita and Fort Baker in the southern end of Marin County. Another locality is near Lands End station about 1 mile northeast of the Cliff House in San Francisco County. "Kinradite" is also found at other places along the coast of California as far north as the Oregon line.

Bloodstone.—Specimens of bloodstone and notes on the occurrence have been furnished by Mr. F. M. Myrick, of Randsburg, Cal., from a new locality discovered by him in San Bernardino County. The stones were found on Brown Mountain in the Death Valley region, about 15 miles north of the St. Stephen stone locality mentioned above. Several pits have been made, the largest of which is 15 feet long, 10 feet wide, and 12 feet deep. The bloodstones are found in a claylike formation in "malpaís" over an area 800 feet long and 200 feet wide. They occur in bunches or pockets containing from a few pounds to more than 30 pounds. The color and quality of the bloodstone found at the surface are as good as those from a depth of 12 feet. Several hundred pounds of rough stone have been mined and a quantity of select material placed on the market.

The mineral is true bloodstone or heliotrope composed of slightly translucent dark leek-green plasma through which bright blood-red and yellowish-red spots, patches, and streaks occur. Some of the plasma has a uniform color and texture over considerable areas, and some contains a few patches and streaks of chalcedony and finely crystallized quartz. A few of the red spots are rounded like drops of blood, but most of the red is in large or small irregular patches and streaks. The different patterns formed in the latter case furnish pretty gem material, but the most valued specimens are those in which the red spots are nearly uniform in size and distribution through the green. Cut gems of this bloodstone have been well received in the Southwest and some of them have brought good prices.

LAZULITE.

CALIFORNIA.

The writer is indebted to Prof. G. Montague Butler, of the Colorado School of Mines, for two gems cut from lazulite matrix from California. The rough material was obtained from Breyfogle Canyon, in Death Valley, by W. B. Patrick, a former student of Prof. Butler's. The lazulite occurs in a vein cutting schist. The vein varies from 1 inch to 5 feet in thickness and can be traced several miles. The lazulite is confined to a comparatively few patches in the vein. Pure blue gems can be cut from some of the lazulite, but Prof. Butler states that they are not as pretty or attractive as those containing matrix. The matrix is chiefly white quartz with occasional brownish patches and seams. In the specimens examined the lazulite varies from pale azure blue to fairly deep azure blue. In one specimen it occurs in both small crystals and crystal aggregates through the white quartz. In the other specimen there is a large crystal or crystal aggregate with less quartz. These gems are unusual and pretty and are said to be very attractive mounted in silver.

OPAL.

NEVADA.

Further information regarding the opal deposits in Humboldt County, Nev., mentioned in this report for 1909, has been given by Mr. Ivan Dow, of Nevada City, Cal. The deposits are on the Miller & Lux ranch, managed by H. E. Rinehart, about 20 miles south of the Oregon State line and 40 miles east of the California State line. Ivan Dow and George D. Matthewson, of Delta, Utah, own an interest in the opal deposits and have been encouraged by finding some fine gem material. Prospecting will be continued during 1912. The precious opal occurs in part as petrifactions of wood and limbs of trees. In such specimens the texture of the wood has not been preserved, but the outline remains with the bark of branches of a slightly different color from the interior. The opal has been declared of fine quality by dealers. Gems of excellent quality obtained from this locality have been seen by the writer.

MEXICO.

A description of a Mexican opal mine was given by T. M. M. MacFarlane in a paper read before the Instituto mexicano de minas y metalurgía, August 7, 1911, of which the following is an abstract:[1]

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[1] Taken from abstract in Eng. and Min. Jour., Oct. 28, 1911, p. 842.

The principal producing opal mines of Mexico are at present in the State of Queretaro, though fine stones have come from Zimapan, Hidalgo. The mine examined is near the top of a range of hills composed of reddish-gray spherulitic rhyolite. The mine was opened in this rock some six years ago at a point where opals had been exposed by weathering. The opal is obtained by quarrying and later breaking up the blocks into 2-inch cubes or less. The face of the quarry is about 40 feet high of which the lower 25 feet is productive. The upper 15 feet of rhyolite is decomposed and carries no opals. It is stripped to the opal-bearing layer and the latter is quarried. Gunpowder is used in blasting the barren rhyolite, but dynamite is necessary in the hard opal-bearing rock. The limit of depth to which opal will be found is not known, but other mines are reported to be producing opal at a depth of 100 feet.

Surface indications for opal called "pintas" consist of a white siliceous sinter filling cavities in the rhyolite. These are considered infallible but furnish no information as to the quality or quantity of opal to be expected. A corroded appearance on the working faces and numerous cavities containing deposits of silica are common in the quarry. Many of the cavities are lined with clear brittle quartz and contain loose deposits of opal. In other cases opal fills the entire spaces in which it occurs, and is intimately joined to the rock either with or without surrounding iron stain. Opal of good quality is found in both occurrences.

About once a week the rough opal is taken to Queretaro for polishing. The stones are first roughly shaped on ordinary large grindstones into the largest sizes consistent with symmetry and beauty. The roughly cut gems are then smoothed on a sandpapering machine and given a final polish on soft rough leather.

QUARTZ.

OHIO.

Occasional clear colorless pebbles are found in the gravel beds in the vicinity of Windsor, Ohio, and a few have been cut for gems. Several small rough specimens and a cut gem were received from Mr. S. Stoughton, of Windsor, for identification. They proved to be transparent quartz pebbles of sufficiently good quality for cutting where such material is desired.

ROSE QUARTZ.

VARIOUS LOCALITIES.

Rose quartz occurs at many localities in the United States, and varying quantities from a number of these have been cut for gems and ornamental purposes. The principal output has come from the Red Rose mine of Samuel Scott, 6½ miles S. 50° E. of Custer, S. Dak. This mine was described in this report for 1908. Other deposits of rose quartz occur in the Black Hills of South Dakota, but so far none have yielded good dark gem material. Rose quartz has been found at several places in Colorado, and promising material occurs in the Wild Rose claim of J. D. Endicott, 6 miles north of Texas Creek, Colo. Deep rich pink rose quartz has been found in Maine, but much of the mineral from that State is rather pale colored. Rose quartz of varying quality has been found in Connecticut and New York. Several deposits have been located in California in widely separated areas; among these are the Parson claim, described below, several deposits near Lemon Cove and Badger, in Tulare and Fresno counties, in Hemet Valley, Riverside County, and in San Diego County.

CALIFORNIA.

The Summer Rose quartz claim of W. D. and George W. Parson is about 8 miles south of east of California Hot Springs, probably in Tulare County near the Kern County line. It is on the west side of Bull Run Ridge in the roughly dissected plateau-like country east of the first high ridge of the Sierra Nevada, a few miles west of Kern River. The elevation at the mine, determined barometrically, is about 7,000 feet above sea level, or nearly 4,000 feet higher than California Hot Springs. The region around the prospect is well timbered with pines, spruce, fir, and arbor vitæ.

The rose quartz ledge was discovered some 15 years ago by George W. Parson, but little attention was paid to it until 1908, when specimens were taken and submitted to dealers. The Summer Rose claim was located in October, 1910. Only assessment work has been done at the prospect, consisting of openings in the hard rock in search of gem material. Much care is required in this process in order that valuable mineral may not be destroyed.

The country over a large area surrounding the prospect is granitic in nature and in the field might be called hornblende-biotite granite. A specimen from adjoining the rose quartz deposit, examined under the microscope, contained andesine and a little orthoclase feldspar, dark-brown biotite, dark-green hornblende, considerable quartz, a little iron ore, and apatite. Such a rock is intermediate between monzonite and quartz diorite, and here might be called coarse quartz diorite. It has disintegrated to a gravelly sandy soil, through which occur spheroidal bowlders of harder rock. The rose quartz outcrops on the steep slope near the crest of a ridge. It is associated with fine graphic granite in a mass of pegmatite. The quartz mass stands about 25 feet above the outcrop on the lower side and is but little higher than the surface of the ground on the upper side. The width exposed between the base of the outcrop and the contact with graphic granite at the top is about 35 feet, but the true thickness could not be determined. About 80 feet of the quartz is exposed in a direction N. 10° W. It is probable the ledge strikes west of north and dips to the west about with the slope of the hill. At the south end of the outcrop the quartz ledge is covered by soil and brush, and at the north it ends rather abruptly on the hillside.

The quartz has been broken by joints into columns and blocks ranging from over 1 foot thick to sheets as thin as one-sixteenth of an inch. Some of it has been crushed into coarse granular masses. Part of the quartz is white, but most of it is rose colored. In places patches of dark rose quartz occur in white or pale colored material. In the same way translucent and nearly clear rose quartz are inclosed in opaque quartz. The gem mineral ranges in color from nearly colorless to very pale delicate pink to deep pink, and some of it has a magenta tint. Much of it is translucent and somewhat opalescent, and some is nearly clear. The several varieties would serve for gems as beads, cabochon-cut stones, and faceted stones. Practically flawless specimens an inch thick and larger pieces with small seams or feathers can be obtained. The perfect specimens are obtained by breaking up coarsely crushed masses of rose quartz, from which they fall out as the fracture or rift planes are exposed. Beautiful rose quartz can be obtained from this prospect, and some of it has brought good prices when retailed in California.

J. A. Edman, of Quincy, Cal., reports the occurrence of pale rose quartz in quartzose schist near Johnsons Bar on the north fork of Feather River, in Plumas County. This rose quartz could probably be obtained in large quantity. Deposits of rose quartz have been found by George D. Ward about 9 miles north of Lemon Cove, near Thomas Homer's ranch, and by Edward Hill near Badger. Specimens with a very good color were seen from the Ward prospect.

RHODONITE.

CALIFORNIA.

Massive, finely granular rhodonite occurs at many localities in California, and some of them have yielded gem and ornamental material. The different deposits yield a similar product, the chief difference being in richness of color. Black manganese oxides are associated with much of the rhodonite, filling seams and cracks, and make pretty contrasts with the pink. Probably the best gem material so far found has come from the Wheeler prospect, about 9 miles north of Happy Camp, in Siskiyou County, but good material has been found near Taylorsville, in Plumas County, and other localities. These rhodonite deposits are associated with sedimentary rocks and occur along belts of manganese-stained slates and quartzites.

A rhodonite deposit on one of these manganese leads has been found on the land of L. F. and George D. Ward, about 3 miles north of Lemoncove, Tulare County. The outcrop examined is on the north side of a draw about one-third of a mile northeast of Kaweah River, and about 1 mile east of Ward's ranch house. The hills at this place are from 300 to 500 feet above the stream beds, and are partly covered with rock outcrops and partly with soil and vegetation. The rocks lying west of the rhodonite are consecutively heavy beds of quartzite, granite and mica schist, slates, and black and white mottled marble. All of these formations, including the manganese bed, are steeply tilted. The rhodonite occurs in two ledges about 35 feet apart, with quartzite between. The ledges form outcrops several feet high and strike about N. 35° W. and dip about 60° NE. The southwest ledge is about 10 feet thick; the northeast ledge is nearly 30 feet thick, but less solid, and contains much quartzite stained with black manganese oxides. The latter is so plentiful in places that it might be of value as an ore of manganese. The rocks, including the rhodonite deposits, have been broken into coarse blocks and contain numerous seams filled with black manganese oxides. Rhodonite could be obtained rather plentifully, but would require considerable hand cobbing to secure the better grades for ornamental purposes. Rhodonite of several shades of color occur, and these are intermixed in some specimens. The rhodonite has a delicate light to dark rose color, but the majority is rather inclined to grayish pink, and some is greenish gray. Both finely granular and rather coarsely crystallized rhodonite occur. The different colors and textures grade into each other and with the black seams and markings would yield contrasting ornamental material. The purer pink varieties, with or without the black seams, could be cut into very pretty gems.

OREGON.

Specimens of rhodonite with information on the occurrence have been received from Mr. C. H. Gillette, of Ashland, Oreg., from a deposit near the Josephine County caves. The rhodonite is associated with black oxides of manganese below a limestone formation. The specimens sent were obtained during prospecting for manganese and had been badly fractured during blasting. The rhodonite is delicate rose pink, and with it is associated gray and a little greenish-gray mineral, also probably rhodonite, and manganese oxides. The texture is very fine grained, nearly compact, so that the material ought to take a good polish. The combination of colors would yield pleasing gems.

SAPPHIRE.

MONTANA.

A large production of sapphires was reported from Montana during 1911. The output came from the Yogo blue sapphire mines in Fergus County; Rock Creek, in Granite County; Dry Cottonwood Creek, in Deerlodge County; and the Missouri River placers east of Helena. The mines operating in Fergus County were the New Mine Sapphire Syndicate and the Yogo American Sapphire Co. These companies obtain sapphires by mining, disintegrating, and washing a rock matrix. The sapphires obtained here are nearly all blue; those from the other localities are varicolored, and fine blue stones are rare. The Yogo American Sapphire Co. commenced operations in July, 1909, but as no report was received by the Survey the output of this company was not included in the tables of production for the years 1909 and 1910. Mr. H. O. Chowen, president of the company, has supplied statistics of production for the last three years, and this total output is given combined with that of other producers for 1911 in the subsequent table. Consequently the figures given for 1911 are a little high, but the great increase over 1910 is also in a large part due to increased productions from other mines.

The output of the New Mine Sapphire Syndicate was also greater than in 1910. Some fine sapphires are reported to have been found at this mine in 1911, two of which were exceptionally good. One of these weighed 3½ carats and the other 2½ carats and both had a beautiful cornflower-blue color. The summer season, in which the washing is done, was better than in 1910, and no cloudbursts occurred to damage the ditch on which water for washing is dependent. The water supply was plentiful and together with the new depositing floors laid down in the previous summer added to the increased production of gems.

The sapphires mined from the other localities mentioned all occur in placer gravel deposits. On Dry Cottonwood Creek some have been mined by dredging, and one dredge was operated by the Consolidated Gold & Sapphire Mining Co., of Butte, in 1911. The American Gem Mining Syndicate works its placers in Granite County by hydraulics and sluicing The few sapphires obtained from deposits of Missouri River were found during gold placer mining.

The production of sapphires in 1911, including those mined by the Yogo American Sapphire Co. in 1909 and 1910, amounted to about 88,477 ounces, of which probably about 86,000 ounces were culls for watch jewels, meter bearings, and other mechanical purposes. There were nearly 384,000 carats of varicolored sapphires of suitable size and quality for gems. The total valuation, in part estimated, placed on the production is $215,313.

TOURMALINE.

CALIFORNIA.

Very little tourmaline was mined in California during 1911. The larger mines were closed, and only a small scattered production was reported to the Survey. Apparently the large output of previous years more than supplied the demand, so that sales were made from gems in stock. H. E. Dougherty, of Hemet, Cal., states that the demand for pink cabochon gem material by Chinese merchants also fell off greatly, and only the largest deep-pink crystals were bought.

MAINE.

Development of the mine near Poland was continued by F. L. Havey, of Lewiston, during 1911. More pockets of tourmaline were opened, and fine white and pale to dark green crystals were found. Many of these would cut into clear brilliant gems. Mr. Havey's tourmaline deposit was discovered in 1910 during the operation of a feldspar quarry, a full description of which has been given by E. S. Bastin.[1] Prior to this, occasional gem tourmalines were found during the feldspar quarrying.

TURQUOISE.

GENERAL CONDITIONS.

Turquoise has been mined in large quantities in the Southwestern States of the United States. Deposits have been worked in New Mexico, Arizona, California, Nevada, and Colorado, and on a small scale in Texas. At a number of these deposits there were remains of ancient workings, pits, shafts, tunnels, and stopes, with dumps of waste rock, made by Indians or other early inhabitants of the Southwest. Some of the deposits were operated under Spanish rule. At most of the ancient workings, stone hammers and axes, pottery, etc., have been found. That turquoise was used by the early inhabitants of this region is shown by the finding of beads and ornaments in the cliff-dwelling and other ruins. The early Spanish explorers found turquoise among the gems highly valued by the Mexicans, who called it chalchihuitl, probably including other minerals under the same name. To the present day the Indians of the Southwest prize turquoise jewelry and sometimes buy the gem lavishly. A

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[1] Geology of the pegmatites and associated rocks of Maine: Bull. U. S. Geol. Survey No. 445, 1911, p. 58.

Navajo Indian sheep herder was seen to buy $125 worth of turquoise in a few minutes' time at a trading store after disposing o some $300 or $400 worth of wool to the trader. It is said that the Indians still obtain turquoise either from localities known only to themselves or from well-known mines either not now in operation or under guard.

Many of the turquoise deposits of the Southwest have been worked intermittently and on a rather small scale. A few, however, have been extensively developed, and some have been operated continuously for a period of years. During some years large outputs have come from a few mines, and in other years many deposits have contributed to the production. In recent years turquoise matrix has been in demand, and large quantities have been mined, resulting in an overproduction. Consequently the demand is at present limited and many mines are closed down. In 1909 over 17 tons of turquoise matrix and turquoise were produced, in 1910 nearly 8½ tons, and in 1911 a little over 2 tons. In 1909 the production came from Mineral Park, Ariz., Cottonwood, San Bernardino County, Cal.; La Jara, Colo.; Esmeralda, Nye, Lincoln, and Lyon counties, Nev.; Cerrillos, Little Burro Mountains, and Hachita, N. Mex. In 1911, turquoise was produced only in the Little Burro Mountains and Cerrillos regions, N. Mex.; Mineral Park, Ariz.; and Esmeralda County, Nev. Of the total production of turquoise and turquoise matrix in 1911 probably not over 10 to 15 pounds was the best selected pure blue gem.

NEW MEXICO.

There are two groups of turquoise deposits in the Cerrillos region—one around Mount Chalchihuitl, 2½ miles east of north of Cerrillos, and the other in Turquoise Hill, about 6 miles east of north of Cerrillos. Mount Chalchihuitl is a small hill lying to the south of east of Grand Central Mountain, of which it may be considered a foothill. It rises some 200 feet above the valleys on its east and west, with moderately steep slopes broken here and there by excavations. Openings for turquoise have been made on the summit and on the northwest, the southeast, the west, and the south sides of Mount Chalchihuitl. Turquoise has been found at several other localities in the neighborhood, and among these are the mines of Michael O'Neil, about three-fourths of a mile southeast of Mount Chalchihuitl, and of A. B. Renehan, about half a mile west of north of Mount Chalchihuitl. Ancient workings were found around each of these deposits and, in most of them, exceed in amount the work done in recent times.

The workings on Mount Chalchihuitl are historic and there are evidences that the deposits were operated both by Indians or other ancient people and under Spanish rule. Rather extended prospecting in modern times failed to discover any large deposits of good turquoise. In a paper "on the Chalchihuitl of the Mexicans"[1] Blake describes the extent and apparent age of the workings on Mount Chalchichuitl and the occurrence of the turquoise. The principal ancient working is described as:

> An immense pit with precipitous sides of angular rock projecting in crags, which sustain a growth of pines and shrubs in the fissures. On one side the rocks tower

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[1] Blake, W. P., Am. Jour. Sci., 2d ser., vol. 25, 1858, pp. 227-232.

into a precipice and overhang so as to form a cave; at another place the side is low and formed of the broken rocks which were removed. * * * The bottom is funnel-shaped and formed by the sloping banks of the débris or fragments of the sides. On this débris, at the bottom of the pit, pine trees over a hundred years old are now growing, and the bank of the refuse is similarly covered with trees.

A review of the early history of Mexico and this region with references to the authors is given, and in this the identity of chalchihuitl with turquoise and the esteem in which it was held by the ancient Mexicans is brought out. The use of turquoise by the Mexicans before the advent of the Spanish, the operation of the mine under Spanish rule ending in an uprising of the Indians when a fall of rock buried some of their number, the presence of broken ancient Indian pottery, and the condition of the workings are given as evidence to show that the excavations are of great age.

A description of the same locality by Silliman[1] confirms Blake's observations and gives notes on the prospecting in progress by D. C Hyde in 1880. Further information on the discoveries made by Mr. Hyde is given by Kunz.[2] This prospecting consisted of shafts sunk in the bottom of the main pit, on the summit of the hill, and on the southeast side, with tunnels from them. Cavern-like excavations were found on each side of the "mountain" and were named by the prospectors "Wonder caves" and the "Mystery." In these workings, according to Silliman, "were numerous stone hammers, some to be held in the hand and others swung as sledges, fashioned with wedge-shaped edges and a groove for a handle." One of these stone hammers weighed a number of pounds and had the wythe and scrub-oak handle still attached. Kunz states that numerous veins of turquoise one-eighth inch to 2 inches thick were found in one of the caves. D. W. Johnson[3] reviews the literature on the locality and discusses the occurrence and origin of the turquoise.

It is evident that the condition of the workings have changed little since the descriptions of Blake, Silliman, and Johnson. A few measurements and estimates made in 1911 show the main pit on the northwest side of the hill to be about 130 feet deep on the upper side and about 35 feet deep on the lower side, the rim about 200 feet across, and the bottom nearly 100 feet across. The large dumps of waste rock removed from this are about 150 yards long by 75 yards wide and 1 to 30 feet deep. These dimensions do not correspond closely with those given by the earlier writers, since this would give the dump an area of less than 2½ acres as compared with some 20 acres reported by Silliman. The upper walls of the pit are still rough with projecting rocks and the lower slopes are covered with talus. The exploratory work done by Mr. Hyde has been concealed by caving or other agencies. The workings on the other parts of Mount Chalchihuitl are less extensive. On the southeast side is an open cut over 100 feet across, with a present depth of 20 feet on the upper wall.

Little can now be seen of the occurrence of the turquoise at Mount Chalchihuitl, but published descriptions show it to be similar to that of other localities described below. The associated rock with its fracturing and alteration and the mode of occurrence of the turquoise at the different localities are very much alike.

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[1] Silliman B., Turquoise of New Mexico: Am. Jour. Sci., 3d ser., vol. 22, 1881, pp. 67-71.

[2] Kunz, G. F., Gems and precious stones, New York, 1892.

[3] Johnson, D. W., Geology of the Cerrillos Hills: School of Mines Quart., vol. 24, 1903, pp. 493-499; vol. 25, 1903.

A few notes on the geology of the region are given before the deposits are described.

Johnson[1] describes the Cerrillos Hills as remnants of laccolithic intrusions into Cretaceous strata. The sedimentary strata covering the intrusions have been eroded away, and the present hills are the more resistant portions of the igneous rocks. The principal rocks are described as augite andesite, hornblende andesite, and mica andesite. Augite andesite is mapped as most abundant and with hornblende andesite forms the matrix for the turquoise. Lindgren[2] in discussing the same rocks points to the fact that orthoclase is present in many of them and that the texture is decidedly holocrystalline and porphyritic. Such rocks belong in the monzonite group.

Examination of thin sections of rock from several places in the areas mapped as augite andesite by Johnson confirms Lindgren's determination. Alteration has made difficult the identification of the feldspars in many sections. In some the striations of plagioclase are largely concealed by secondary minerals and add uncertainty to the determination of altered orthoclase present in the same sections. Locally the texture of the monzonites is so fine grained that they might be called latite, of which andesite is a variety. A specimen from an area mapped as hornblende andesite had a porphyritic texture and was composed of such minerals as are characteristic of diorite or andesite.

The rocks have been strongly fractured, especially in those areas where turquoise is now found. Both large and small fissures were formed, and numerous minor joints cutting the rock in all directions. The rocks have been considerably altered in many places, and around the turquoise-bearing areas alteration has been extensive. Alteration was favored by the easy channels open to solutions in the badly fractured areas. The process outlined by Lindgren offers a good explanation of the present associations at the turquoise deposits. The original monzonite porphyry was greatly altered by mineralizing solutions in fracture zones and abundant secondary sericite developed. Later weathering by surface waters produced kaolin and other hydrous minerals characteristic of the oxidized zone and among them turquoise.

In describing the occurrence at Mount Chalchihuitl, Johnson[1] says.

> The rock is yellow or white in color, sometimes mottled or streaked with iron stains. * * * The turquoise occurs as seams throughout the rock, filling crevices formed by crushing and shearing, and as little nodules in streaks or patches of kaolin. The color varies from green through greenish-blue to pure sky-blue. Many of the specimens are marred by streaks of limonite, kaolin, etc.

Practically all the rock on Mount Chalchihuitl is altered. The general appearance is white to gray and yellow, but some is stained brown and purplish in small masses. Most of it has a somewhat porous earthy texture but is not broken with a hammer as easily as its appearance would lead one to expect.

At Michael O'Neil's turquoise mine turquoise has been found over a distance of about 300 yards in a direction N. 30° W. Ancient workings and prospecting for silver have left numerous openings along this turquoise lead, so that without the aid of a guide it was difficult to determine at what places turquoise had been found. About a dozen shafts and a large number of prospect pits and cuts had been made over a belt of country about 250 feet wide. Some of the shafts were 40 to 50 feet deep and around them were open cuts. At one of these a track for a mine car had been laid through the cut to a platform over the shaft to expedite the removal of rock. The turquoise is associated with decomposed rock quite similar in appearance to that on Mount Chalchihuitl. The rock is porous white to gray, and part is stained with iron oxides. Less altered phases are gray or drab, and some that has suffered little weathering is dark speckled gray. The turquoise occurs in seams, veinlets, and segregations, as in the other deposits of this region. Some good pure blue gem has been found as well as considerable good matrix associated with brown limonite iron stains. Turquoise has been worked intermittently at this mine during the last few years, but little was done in 1911. Oxidized copper ores were found in the workings of the north end of the O'Neil mine.

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[1] Johnson, D. W., Geology of the Cerrillos Hills: School of Mines Quart., vol. 24, 1902–3, pp. 456–477.

[2] Lindgren, Waldemar, The ore deposits of New Mexico: Prof. Paper U. S. Geol. Survey No. 68, 1910, pp. 165–166.

At A. B. Renehan's claim several pits, shafts, and open cuts had been made. Some of these were in part ancient workings. The latest work consists of an open cut about 75 feet long, 3 feet to 25 feet deep, and 6 feet wide. The rock formation is quite similar to that around Mount Chalchihuitl. The badly decomposed rock is nearly white and porous and less altered phases are bluish-gray. Turquoise is found in seams and veinlets in the decomposed rock. Some very good blue turquoise is reported to have been found. The claim was worked in a small way during 1911, but no turquoise was sold.

Turquoise Hill is a low elbow-shaped ridge rising from 100 to 300 feet above the plains northeast of the Cerrillos Hills. It has four summits—a main summit and others, about 250 yards S. 25° E., about 300 yards west, and about 500 yards S. 75° W., respectively. The elevation of the main hill is about 6,400 feet above sea level. The hills are well rounded and slope gradually into the plains. Rock outcrops are not prominent, but the surface is covered with angular blocks and small fragments of rock, among which vegetation has a slight foothold. Like the plains, the hills are covered with only a light crop of desert grass, a little sagebrush, cactus, and a few scattered pine trees of stunted growth. The nearest water is Alamo Creek, about 2 miles north of Turquoise Hill, and water for camp use is hauled from Bonanza along this creek. The principal turquoise deposits have been found in the three lower hills, but a little turquoise has been found on the northeast side of the main hill near the bottom. There were rather extensive ancient workings over the best deposits and in some places the greater part of the turquoise had been removed.

The famous mine of the American Turquoise Co., often called the "Tiffany mine" though not owned by Tiffany & Co., is located in the southeast hill. Other claims have been located around this mine, but the quantity of turquoise found has been limited. The old Castilian mine is located on the westernmost hill, and around it numerous claims have been located, accompanied by rather extensive prospecting. The openings on the third hill, lying north of east of this, are small and may be considered a part of those surrounding the Castilian mine. The American Turquoise Co. has six claims including those composing the Tiffany mine and part of the Castilian mine.

Other names have been connected with other claims around Turquoise Hill, but some of these claims are said to have lapsed through want of assessment work. Litigation due to claims dating back to a Spanish land grant of 1728 has tied up the development of many of these turquoise deposits, especially the Tiffany mine. A decision of the court has ruled that some of the deposits lie outside of the Spanish land grant, but there is still some question about others, and development is accordingly being delayed. Active operations have been suspended at the Tiffany mine for several years, but assessment work has been kept up by James P. McNulty, superintendent, for the American Turquoise Co. of New York. The workings consist of numerous pits, open cuts, shafts, tunnels, drifts, and stopes. Some of these openings are ancient, and old stopes have been encountered in the modern tunnels. Two of the larger tunnels, 450 and 225 feet long, respectively, have been driven within the last year or two. They were started about 300 feet east of the company's camp and about 195 feet apart, and were driven in a north of east direction, connecting with shafts and other previous workings. Crosscuts were made from them along promising cross veins. The depth to which the ancient workings had been carried could not be ascertained, but was evidently as much as 100 feet, if not more.

The rock encountered in the workings is probably all monzonite porphyry, which presents different aspects according to the amount of alteration it has undergone. The less altered rock is dark speckled gray and very tough, and that which is more decomposed is light-gray to nearly white, with white spots. The following minerals were observed in a thin section of the less altered rock: Phenocrysts of plagioclase and orthoclase, much clouded with kaolin; abundant epidote; a very little biotite, magnetite, apatite; and abundant patches of calcite. The groundmass was also clouded with kaolin. The epidote is secondary and probably formed from augite. Apatite occurs rather plentifully for that mineral in stout prisms and laths.

The rock has been strongly fractured and jointed and decomposition with kaolinization has been extensive along some of the joint systems. Turquoise has been found in veinlets, seams, and segregations, filling these fissures, joint planes, and fracture zones. The mine workings have followed two sets of veinlets of turquoise striking north of east and west of north with steep dips. Smaller branch veinlets were found to extend from these a few feet into the surrounding rock. The turquoise-bearing streaks of badly decomposed rock are many feet thick in parts of the mine. A few veinlets of quartz and seams of limonite stain are associated with the decomposed rock. The greater part of the turquoise occurs in seams and veinlets but there are some segregations in nodular masses in badly fractured and decomposed rock. There is also a tendency to lens and nodular structure in some of the streaks of turquoise. The turquoise seams range from a small fraction of an inch up, and some an inch thick have been found. The rock in the tunnel and a drift about 40 yards east of the turquoise-bearing zone is stained blue and green with copper minerals.

The best turquoise from the Tiffany mine has a fine dark sky-blue color with an even texture. It is about 6 in the scale of hardness, and has a smooth to conchoidal fracture. Pale-blue and greenish-blue turquoise also occurs. As a rule the best color is found in small seams and masses, but veinlets of turquoise of good color as much as one-half inch thick have been found. Excellent matrix turquoise has formed where the brown limonite stains have penetrated and filled seams and interspaces in turquoise veinlets and segregations. Such matrix, when cut, would present beautiful contrasts of fine blue and brown with a variety of patterns and markings. Little pure turquoise has been removed since the last regular mining a number of years ago. Some matrix containing bright-blue turquoise in brown iron-stained rock has been encountered in exploration during recent assessment.

Of the many excavations at and around the old Castilian mine, those of the ancients were probably more extensive than the recent ones. The extent and nature of much of the ancient work has been concealed by caving and other agencies of time and by modern work in the same places. Large pitlike depressions and many smaller openings mark some of the ancient work. Numerous prospect pits, trenches, and shafts have been made in recent times. As would be expected little turquoise was left in sight from the last work, and since the deeper workings were not opened little could be learned of the nature of the deposits.

The rock at the Castilian mine is quite similar in appearance to that at the Tiffany mine and may be called monzonite porphyry. Alteration has been extensive and the resemblance of the decomposed rock at each mine is striking. A thin section of the altered rock from one of the shafts at the Castilian mine contained phenocrysts of plagioclase and orthoclase with a groundmass of lath-shaped feldspar crystals with partial trachytoid texture. Other minerals were plentiful, pyrite crystals, magnetite, apatite, and a few shreds of pale brown biotite, much secondary epidote and calcite. Less altered phases of the monzonite porphyry outcropped in places near the mine workings.

From the nature of the work and the type of rock encountered it is probable that the occurrence of turquoise at the Castilian and surrounding claims is similar to that at the Tiffany mine. Several lines of prospects and open cuts have been made in a northeast-southwest direction and other workings also indicate leads of turquoise with a northwest trend. Some good turquoise has been found in the Castilian mine, but a larger proportion is reported to have a greenish-blue shade than at the Tiffany mine.

Other claims have been located east of the Tiffany mine and on the northeast side of the main hill by Mr. McNulty and others. Some of these are reported to carry also copper and gold. A little greenish-blue turquoise has been found in seams and nuggets or nodules in a few of these claims.

CALIFORNIA.

Turquoise has been mined in the northeastern part of San Bernardino County, Cal., by the Toltec Gem Mining Co. and the Himalaya Mining Co., both of New York. These companies have not operated their mines for several years, the Himalaya Mining Co. having closed down in 1903. The Toltec Gem Mining Co. owns three groups of claims known as East Camp, Middle Camp, and West Camp. In a letter from Mr. C. F. Lamont, of New York, treasurer, East Camp is described as 50 miles from Manvel, Middle Camp 5 miles from East

Camp, and West Camp 4 miles from Middle Camp and near the min of the Himalaya Mining Co. The latter mine is about 12 miles N 60° E. of Silver Lake, a station on the Tonopah & Tidewater Railroad A visit to the region was made by way of Silver Lake as the neares railroad point, but a guide familiar with the different localities coul not be obtained and only the Himalaya mine was examined Remains of ancient workings with stone hammers are reported t have been found at all of the turquoise deposits mentioned above One small crude stone hammer was found near the Himalaya mine a the time of examination.

The Himalaya turquoise mine is on the west side of a group of hill lying northeast of Silver Lake. The hills are rather rough and fron them broad débris-filled washes with low ridges slope toward Silve Lake Valley. With the barometer reading 900 feet at Silver Lake th elevation at the turquoise mine was 3,150 feet above sea level. Th hills are bare, vegetation consisting chiefly of scattered sagebrus and a few cacti. No water occurs at the surface near the mine but supply for the camp was obtained from a well. The camp is in draw about half a mile southeast of the mine. The topographi relief between the gulches and hills around the deposit is from 100 t 500 feet.

The chief workings are in the northwest side of a ridge with rathe steep slopes. Other openings have been made to the northwest across a gulch. The workings lie in a north of east and south of west direction and consist of many tunnels, crosscuts, stopes, an open cut, and a shaft. The open cut is nearly 75 feet long and 20 to 4 feet deep and extends from the surface to the tunnel level. A tunnel 75 feet long connects the bottom of the open cut with the surface o the hill and another tunnel enters the open cut from a higher level on the hill side. From the open cut another tunnel has been driven over 100 feet farther south of east. Workings from this tunnel consist of about 100 feet of crosscuts, a large shaped room or downstope 10 feet deep, and a 25-foot shaft in the bottom of the room. Five other irregular benches and tunnels were made in the walls of the open cut, presumably before the latter was carried to its present depth. The dumps of waste rock from the workings cover a large area on the hillside and from them there is a fine view across the desert over Silver Lake Valley to the mountains at the south end of Death Valley.

The turquoise is associated with granite porphyry and this is included in an area of granite. A series of older rocks, probably of pre-Cambrian age, consisting of biotite schist and gneiss, hornblende gneiss, biotite granite gneiss, and pegnatite, outcrops south of the camp. The contact of the granite with this series strikes north of east. Some of the granite contains small hyacinth-colored garnets, and the feldspars are colored a strong pink by inclusions of hematite dust. The granite porphyry in which the turquoise occurs has been decomposed to a spotted buff and gray color. Rough hard ledges of quartz and silicified porphyry outcrop on the hills around the mine. Some of these ledges are heavily stained with limonite and hematite. In hand specimens of the decomposed porphyry, phenocrysts of white decomposed feldspar, glassy quartz, and biotite are recognized in a groundmass. Under the microscope were observed orthoclase quartz, and partly altered shreddy biotite crystals in a groundmass composed of similar minerals, and grains and veinlets of jarosite or an allied mineral. A somewhat kaolin-like mineral clouds parts of the section. A section of turquoise matrix showed similar minerals with a veinlet of secondary quartz, much sericite, and limonite stains.

Turquoise occurs in seams, veinlets, and a series of nodules and plates in joint planes and fracture zones in the decomposed rock. Also in patches in quartz veins and impregnating decomposed rock. The turquoise seams cut the rock in various directions. From the irregular shape of the workings it was not possible to determine what position the best turquoise leads occupied. It is probable the best gem was found in a rather limited area in a fracture zone somewhat like a chimney deposit. Much quartz with occasional rough crystals is associated with the turquoise. Limonite and a little hematite stain the quartz and turquoise matrix yellowish and brown. The presence of jarosite was recognized after a similar occurrence was determined by Sidney Paige of the United States Geological Survey, in turquoise matrix from the Burro Mountains, N. Mex. The yellow grains and seams were identified by comparison with crystallized jarosite found in a cavity in a quartz veinlet.

As usual with turquoise deposits, a variable grade of turquoise was found. Only fragments and small pieces of veinlets of gem turquoise were left around the mine, but a sufficient variety was seen to form an opinion of the quality of the gem. Considerable low-grade turquoise was seen. The greater part was soft and pale blue, and some might be called semiturquoise. Part was bluish-green and quite hard. The semiturquoise was associated with badly kaolinized soft rock. Some hard pure blue turquoise, that would yield beautiful gems, was observed. This was light baby blue to fairly dark blue. Matrix turquoise, with a variety of markings and colors, occur in the mine and would yield gems showing blue to greenish-blue turquoise, with white, gray, yellow, and brown matrix.

VARISCITE.

There was a large decrease in the production of variscite in 1911 from the two preceding years. This mineral was found at so many localities in the deserts of Nevada and such large quantities were mined that the market was overstocked. The production reported to the Survey was about 540 pounds, as compared with 5,377 pounds in 1910 and 7,135 pounds in 1909. Some of the variscite was reported with the rough gem value and some was given as cut gems. The value of the production in 1911, estimated in part, is placed at $5,750, as compared with $26,125 in 1910. The principal value of the variscite production was from Utah, where the "amatrice" variety is still being mined and cut in some quantity. A production was reported from the Maguire utahlite mine, the first discovered in Utah.

No production of variscite was reported from the Edison & Bird mine north of Lucin, Utah, but a quantity was obtained during assessment work and in opening a newly discovered deposit just southwest of the original four claims. The new deposit is on the Sentinel claim overlapping the southwest corner of the Protection claim, as described in this report for 1910. A specimen from the new claim was sent to the

Survey by Messrs. Edison & Bird. It measured 6 by 4 by 3 inches and was marked similarly to some of the variscite obtained from the Utahlite claim, adjoining the Protection claim on the north. The color of this is a good green, and the markings are such that it would yield beautiful matrix gems. As mentioned in this report for 1910, a granular crystallized variscite occurs at the Edison & Bird mine. A detailed study of the crystallized material was made by W. T. Schaller,[1] of the United States Geological Survey. In the more coarsely crystallized granular variscite some of the crystals are nearly whole, and in the finer-grained material they were only partly developed. Good crystals for measurement occur in small cavities in some of the granular variscite. Mr. Schaller found the crystals to be orthorhombic, with rather simple forms, b(010), m(110), e(012), and in a few crystals a(100). Further investigation of new material, supplied by Messrs. Edison & Bird, has discovered other forms with few, if any, of those enumerated above associated with them, and these crystals will be the subject of further investigation. Three different orientations are given for the crystals, and the relations between these and the similar minerals, scorodite, strengite, and phosphosiderite, are discussed. A chemical analysis was made by Mr. Schaller and the formula deduced from it agrees very well with that usually given for variscite—$Al_2O_3.P_2O_5.4H_2O$. The analysis showed H_2O, 22.68 per cent; P_2O_5, 44.73 per cent; Al_2O_3, 32.40 per cent; with V_2O_3, 0.32 per cent; Cr_2O_3, 0.18 per cent; and Fe_2O_3, 0.06 per cent. No nickel, cobalt, copper, manganese, arsenic, calcium, or magnesium were found.

A further description of Edison & Bird variscite deposits has been given by Leon J. Pepperberg.[2] In this article the location of the deposit is given as sec. 23, T. 8 N., R. 18 W., of the Salt Lake meridian and base line.

MISCELLANEOUS.

BEACH PEBBLES.

CALIFORNIA.

Photographs and descriptions of a choice lot of gems cut from beach pebbles found near Los Angeles were loaned by Dr. Joseph E. Pogue, of the United States National Museum. This information was furnished by Mr. James D. T. Chalmers, of Los Angeles, and is descriptive of a collection of over 500 stones prepared by him. The collection is the result of study and experiment in cutting promising looking pebbles gathered on the beaches during the course of several years. Little attention was paid to mineral varieties, but stones with peculiar textures, odd markings, and pleasing colors were chosen for cutting. The gems include chalcedony, agate, jasper of various colors, and probably several types of rock which have been more or less silicified and altered. Descriptive terms suggested by characteristic features have been used by Mr. Chalmers for some of the stones, such as "enychthyol," "flower stone," "wire agate," "fish egg," and "Japanese stone," but a more comprehensive name for all those not recognized as definite minerals is "beach pebble gems."

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[1] Crystallized variscite from Utah: Proc. U. S. Nat. Mus., vol. 41, 1912, pp. 413-430.

[2] Min. and Sci. Press., Aug. 11, 1911, p. 233.

The chalcedony pebbles may be nearly transparent and colorless, translucent gray, pure white, yellowish, reddish, etc. Some of them are mottled with these colors, generally gray and white. The translucent gray varieties are commonly sold as moonstones along the California coast. Jasper in various shades of red, brown, yellow, green, and black, either pure or mottled, forms an important part of other gems. Vari-colored jasper and chalcedony occur together in some gems in odd and pleasing patterns and some chalcedony pebbles have tangled wirelike inclusions. Gems have been cut from vari-colored jasper which exhibit flowerlike patterns.

Beach pebbles which yield very pretty gems are found on the southern end of Santa Catalina Island, Cal., about 1½ miles west of Avalon. The Catalina Novelty Co., of Avalon, has been engaged in cutting these stones for several years, and has applied the name "catalinite" for trade use among tourists. The stone is obtained in all sizes from cobbles over 6 inches thick to small pebbles, but good gem material is not plentiful. They are found over nearly a mile of beach and are probably derived from vein material or deposits from solution in the rock formations now being eroded away along the shores. The composition of these pebbles is variable, so that no definite scientific name can be applied to them. The component minerals are not easily determined, but in some of them there are quartz, calcite, some zeolite-like minerals, hematite dust and particles, limonite stains, and a little pyrite. The hematite dust in quartz forms red jasperlike patches; the quartz and calcite are white and gray; and the zeolite-like minerals are gray and green. Limonite adds yellow and brown stains. The contrasts between the mottled green, gray, white, yellow, brown, and red minerals in polished specimens are very pleasing, and gems for a variety of uses can be cut from "catalinite."

OREGON.

Beach pebbles are collected and cut for the tourist trade along the coast of Oregon as in southern California. The tourists also collect these pebbles to carry off as souvenirs, either polished or in the rough. The curio stores in such coast towns as Newport and Nye Beach and in some inland towns handle many beach pebble gems, and some of them have their own cutting plants. Mr. Sigurd Landstrom, of Lebanon, one of the interior towns, furnished two specimens of beach pebble gems from Oregon for examination. One of these was a cherry-red carnelian and the other a translucent gray agate in which there was a large dark-gray cloudlike inclusion. Both specimens were very pretty. Other types of stones are found and cut, including moss agate, jasper, petrified wood, and rock specimens displaying attractive colors and markings.

FOSSIL CORAL.

Fossil coral is found in several of the Middle Western States, and has been cut for ornamental purposes. During 1911 some of it was cut by the Petosky Steam Agate Works, of Petosky, Mich. Miller Bros., of Iowa City, Iowa, report that in past years they have cut a quantity of fossil coral during the winters for the tourist trade in the summer. Pieces cut into paper weights sell for 50 to 75 cents apiece. A rough specimen of a variety locally called "fish-egg" coral was kindly sent to the Survey. G. H. Girty, of the Survey, classed this coral as a species of Favosites from the Devonian. It is finely granular crystallized calcite in which the coral structure has been well preserved. A columnar or speckled marking is obtained according to which direction the stone is cut. The color is yellowish-gray, and polishing brings out beautifully the markings due to the texture.

PRODUCTION.

There were many changes in the production of gem minerals reported to the Survey during 1911. The output of some minerals formerly large declined greatly and other minerals formerly of less importance were handled in increased quantities. The production of sapphire in Montana was much greater than during the three preceding years, owing to renewed activity in mining both blue gems in the matrix and varicolored stones from placer deposits. The output of tourmaline and kunzite in southern California, formerly large, nearly ceased. The production of opaque blue-green gems, such as turquoise, variscite, and some copper-ore gems, declined greatly. Increased interest in such gems as agate, moss agate, jasper, and bloodstone resulted in a greater production. The new emerald locality of North Carolina, discovered in 1909, has yielded gems which have been conservatively estimated as worth $10,500 during the last three years.

The total production of gems and precious stones reported to the Survey during 1911 shows an increase over 1910, but is considerably lower than in the years 1907 to 1909. The value of the production in 1911, as reported to the Survey and estimated in part, was $343,692, as compared with $295,797 in 1910. In preparing these statistics it is necessary to estimate values for the output of some minerals, and in doing this the values chosen are an attempt to represent the first sales value of the rough mineral. In some cases the gems are reported to the Survey as cut stones with the proper value for such material, and in other cases it is not evident in what condition of elaboration the stones are reported. The statistics more nearly represent the first values that the rough material brings or might be expected to bring. This same gem material may bring four or five times as much after cutting and placing on the market.

Production of precious stones in the United States in 1908, 1909, 1910, and 1911.

	Value.				Remarks.
	1908	1909	1910	1911	
Agates, chalcedony, etc., moonstones, etc., onyx.	$1,125	$750	$2,268	[a] $8,128	About 800 pounds, part polished; Arizona, California, Colorado, Missouri, Montana, Utah, and Wyoming.
Amethyst	210	190		725	North Carolina and Colorado.
Benitoite	3,638	500			No production reported.
Beryl, aquamarine, blue, pink, etc.	7,485	1,660	5,545	2,505	About 23 pounds, rough and selected; California, Colorado, Maine, Massachusetts, and North Carolina.
Californite		[a] 18,000	[a] 8,000	150	40 pounds; California.
Catlinite					No production reported.

[a] Estimated or partly so.

Production of precious stones in the United States in 1908, 1909, 1910, and 1911—Con.

	Value.				Remarks.
	1908	1909	1910	1911	
Chiastolite	....	....	....	$25	California.
Chlorastrolite	$25	$2,400	[a] $2,000	1,992	Rough and cut gems; Michigan.
Chrysocolla	600	300	....	....	No production reported.
Chrysoprase	[a] 48,225	[a] 84,800	[a] 9,000	[a] 13,550	2,035 pounds; California and Arizona.
Cyanite	....	....	....	....	No production reported.
Diamond	[a] 2,100	2,033	[a] 1,400	[a] 2,750	Arkansas and California.
Diopside	120	....	....	....	No production reported.
Emerald	....	[a] 300	[a] 700	[a] 9,500	2,510 carats rough; estimated yield of cut gems, 700 carats; North Carolina.
Epidote	....	15	....	....	No production reported.
Feldspar, sunstone, amazon stone, etc.	2,850	[a] 2,700	2,510	175	145 pounds; California and Colorado.
Garnet, hyacinth, pyrope, almandine, rhodolite.	13,100	1,650	3,100	2,065	Rough and selected; Arizona, California, Colorado, Montana, and New Hampshire.
Gold quartz	1,010	....	1,000	1,700	California and Colorado.
Jasper, petrified wood, bloodstone, etc.	....	100	475	2,240	California and Montana.
Malachite, azurite, and azurmalachite.	5,450	2,000	550	800	Arizona, California, and Colorado.
Opal	50	200	270	[a] 1,875	Nevada, Oregon, and California.
Peridot	1,300	300	....	360	33 pounds; Arizona.
Phenacite	95	50	50	....	No production reported.
Prase	....	....	100	....	Do.
Pyrite	....	....	....	....	Do.
Quartz, rock crystal, smoky quartz, rutilated, etc.	3,595	2,689	1,335	2,140	664 pounds; California, Colorado, Texas, North Carolina, and Maine.
Rose quartz	568	2,970	2,537	1,744	9,920 pounds; South Dakota and California.
Rhodocrósite	....	....	....	....	No production reported.
Rhodonite	1,250	125	[a] 6,200	1,300	California.
Ruby	....	....	....	[a] 210	North Carolina and Indiana.
Rutile	....	25	....	....	No production reported.
Sapphire	[a] 58,397	[a] 44,998	52,983	[a] 215,313	88,477 ounces; Montana, North Carolina, and Indiana.
Smithsonite	[a] 1,200	300	....	25	New Mexico.
Spodumene, kunzite, hiddenite.	[a] 6,000	15,150	33,000	75	California.
Thomsonite	35	100	610	1,500	Michigan.
Topaz	4,435	512	884	2,675	Texas, California, Utah, Colorado, and Arizona.
Tourmaline	[a] 90,000	[a] 133,192	[a] 46,500	16,445	Maine and California.
Turquoise and matrix	[a] 147,950	[a] 179,273	[a] 85,900	[a] 44,751	4,363 pounds; New Mexico, Arizona, and Nevada.
Variscite, amatrice, utahlite	14,250	35,938	[a] 26,125	[a] 5,750	540 pounds; Nevada and Utah.
Miscellaneous gems	....	1,060	2,755	3,224	Obsidian, datolite, fossil coral, beach pebbles, pink apatite, and ornamental stones with trade names.
Total	415,063	534,380	295,797	343,692	

[a] Estimated or partly so.

IMPORTS.

The imports of precious stones into the United States in 1911, as reported by the Bureau of Statistics, were large and have been exceeded only by those of 1906. The increase over the imports of 1910 amounted to only $115,949, and over those of 1909 to $502,927. The imports were nearly three times as great as those of the year 1908, during the financial depression following the panic.

The following table shows the value of the diamonds and other precious stones imported into the United States from 1906 to 1911, inclusive:

Diamonds and other precious stones imported and entered for consumption in the United States, 1906–1911.

Year.	Diamonds.					Diamonds and other stones not set.	Pearls.	Total.
	Glaziers.	Dust or bort.	Rough or uncut.	Set.	Unset.			
1906	$104,407	$150,872	$11,676,529	$305	$25,268,917	$3,995,865	$2,405,581	$43,602,476
1907	410,524	199,919	8,311,912	......	18,898,336	3,365,902	680,006	31,866,599
1908	650,713	180,222	1,636,798	......	9,270,225	[a] 1,051,747	910,699	13,700,404
1909	758,865	50,265	8,471,192	......	27,361,799	[a] 3,570,540	24,848	40,237,509
1910	213,701	54,701	9,212,378	......	25,593,641	4,003,976	1,626,083	40,704,487
1911	199,930	110,434	9,654,219	......	25,676,302	3,795,175	1,384,376	40,820,436

[a] Including agates. Agates in 1906, $20,130; in 1907, $22,644.

GRAPHITE.

By Edson S. Bastin.

INTRODUCTION.

The edition of the 1909 chapter on graphite being exhausted, the general sections on the origin, properties, and uses of graphite and the bibliography contained in that chapter are here reprinted with corrections and additions.

The production of natural graphite in the United States is sporadic, because the milling of disseminated flake graphite is still in the experimental stage and the product is of uneven grade. Because of this unreliability of the domestic supply most of the large consumers prefer to depend on imported material.

In 1911 the quantity of graphite imported into the United States for consumption was 20,702 short tons, valued at $1,495,729. In contrast to this the total domestic production was 3,618 short tons of natural graphite, valued at $288,465, and 5,072 short tons of manufactured graphite, valued at $664,000.

The cause of the unsatisfactory condition of the domestic industry is to be found in (1) the superiority of much of the Ceylon graphite to any graphite that is mined in this country; (2) the low cost of labor in Ceylon, which permits cheap mining, careful sorting, rubbing up, and blending of the product; (3) the facts that the largest domestic deposits are schists which carry small flakes of graphite disseminated through them and that the separation of the graphite from the accompanying minerals, especially mica, in such rocks is a problem of unusual difficulty. The one firm which can be said to have become firmly established in the treatment of such graphite rocks, the Joseph Dixon Crucible Co. possesses important advantage over other firms in that it manufactures much of its product into graphite paints, graphite grease, etc., before placing it on the market. When the margin of profit is small, such control of markets becomes of vital importance.

To-day there are more abandoned graphite mines and mills in the United States than there are in operation. The number of times that some of these properties have changed hands in the course of a few years evinces a record of misrepresentation and disappointment that can hardly be equaled in any other branch of mining, and many properties have been notoriously associated with stock manipulations of doubtful character. It should be clearly understood by anyone who contemplates the development of one of the flake-graphite deposits that the technology of concentrating such materials is yet in its infancy; that there are no well-established systems of treating the materials, such as exist, for example, for the treatment of gold or copper ores; and that the product obtained is variable in quality and in market value and subject to severe competition with foreign graphite. The largest part of the foreign graphite that comes into this country is brought in by American firms who either control or own the foreign mines or have purchasing agents abroad, and are, therefore, in a position to take immediate advantage of any change in the markets at home or abroad. In general, the cost of producing flake graphite is so high and the price at which it is sold so low that even under the most economic conditions the margin of profit is small. Moreover, certain rocks that carry graphite contain other minerals which preclude any possibility of successful concentration—such, for example, are rocks in which graphite flakes are interleaved with mica—and a careful study of the material by an expert should precede any attempt at development.

In a later paragraph the uses of graphite are discussed. These uses are manifold, but it should be remembered that graphite from any one property will be adapted for only certain of these uses, and that not only the purity of the graphite but its physical properties are of importance in determining the purposes for which it is suited. Crucible manufacture, for example, demands a flaky or fibrous graphite high in carbon, and Ceylon lump, which retains its flaky character after grinding, is excellently adapted to this use. For foundry facings, on the other hand, an earthy, impure graphite is usually adequate. For many purposes the best result can be obtained only by a careful blending of graphite of several different kinds. This is the case in the manufacture of pencils.

The blending in various proportions of slightly different grades of graphite from different mines to obtain products which meet the varied requirements of purchasers is one of the steps in preparing the Ceylon graphite for the market. To a certain extent blending is practiced by some American dealers, especially in marketing the amorphous forms.

PHYSICAL AND CHEMICAL PROPERTIES.

Chemically, the purest graphite is carbon with a fraction of 1 per cent of ash and volatile matter. In the trade graphite is frequently referred to as plumbago, or black lead. The graphites of commerce contain various impurities, sometimes in large quantities. Graphites showing 80 to 95 per cent graphitic carbon are pure enough for the requirements of the general trade, and for many uses, such as paint making, graphites with as low as 30 to 35 per cent of graphitic carbon are employed. The mineral possesses certain physical characteristics which usually enable it to be easily recognized. These are its steel-gray to blue-black color, extreme softness (1 to 2 in the scale of hardness), greasy feel, and the property of making a black metallic mark on paper. It is opaque in even the thinnest flakes, and the flakes, though flexible, are not elastic. Its temperature of fusion or volatilization is unknown, but is probably above 3,000° C. It is combustible at temperatures between 650° and 700° C. The specific gravity generally lies between 2.20 and 2.27. The only mineral with which graphite might be confused is molybdenite, from which it differs slightly in color, the molybdenite having a somewhat bluish or greenish tinge. The two minerals may be distinguished by simple blowpipe tests. Graphite is in general a better conductor of electricity than are most of the amorphous forms of carbon. Tests by P. M. Lincoln, of the Niagara Falls Power Co., showed a specific resistance of 0.00032 ohm in an artificial graphite electrode, while an amorphous carbon electrode of the same size showed a resistance of 0.00124 ohm.

In the trade two principal varieties of graphite are generally recognized. The graphite that possesses a lamellar, scaly, flaky, or fibrous structure is classed as crystalline. The other forms of graphite, of whatever occurrence or appearance, are classed as amorphous. The two varieties are not sharply differentiated, and the distinction appears to be largely in the size of the graphite particles. Much of the so-called amorphous graphite mined in the United States is shale or slate containing varying percentages of carbonaceous material. In such cases it is often impossible even with chemical tests to tell whether the carbon is graphite or amorphous carbon.

From the commercial standpoint the physical character of graphite is usually of the utmost importance as will be further discussed in the section on uses.

ORIGIN.

Graphite is known to occur in nature in each of the three great groups of rocks, igneous, sedimentary, and metamorphic. It also occurs as veins which may traverse rocks belonging to one or all of these groups.

Graphite has been observed in numerous places in igneous rocks so intercrystallized with the other rock minerals as to leave no doubt that it formed a part of the molten magma from which the rock crystallized. In some such occurrences, where the igneous rock is associated with carbonaceous sediments, it is probable that the magma absorbed carbon from these sediments, but in others it is equally probable that the graphite is of inorganic origin, or at least came up from great depths as an integral part of the igneous magma. The frequent occurrence of graphite in meteorites also indicates that it is not always of organic origin. Except where igneous rocks are associated with carbonaceous sediments, the amount of graphite in them is usually small and such occurrences are generally of no commercial importance.

Graphite has been found in unaltered sedimentary rocks, but in all such cases it is present in small amounts and has not been formed in place, but has been washed or weathered out of older igneous or metamorphic rocks.

The deposits of crystalline graphite which are of greatest commercial importance are veinlike in form and have apparently been deposited along fractures in the rocks. Foremost among these in size and importance are the famous Ceylon deposits, which are described further on in this report. The deposits near Dillon, Mont., also described in this report, and certain deposits in the counties of Ottawa and Argenteuil, Quebec, belong to this type. Very little is definitely known in regard to the origin of such vein deposits, although numerous theories have been proposed. It is certain that they were deposited along fracture planes in the rocks, and they were probably formed at considerable depths, but at temperatures which in some cases at least did not exceed 575° C. (7).[1] In some localities they are associated with graphite deposits of contact metamorphic origin and were probably formed during the later stages of such metamorphism (7).

Many of the commercially important amorphous graphite deposits were coal beds which have been partly or wholly converted into graphite by the metamorphic effect of intrusive igneous rock magmas. Such is probably the origin of the important deposits of Sonora, Mexico (28), and the deposit of Turret, Colo. (8).

The large group of so-called disseminated deposits in which the graphite occurs in small flakes disseminated through a foliated rock, usually a crystalline limestone or a schist, is of great importance in the United States, Canada, and Germany. Such deposits have probably been formed by the dynamic metamorphism of sediments which carried carbon in some form scattered through them (7). Metamorphism by igneous rocks has also played a part in the formation of some of the deposits of this type.

MANUFACTURED GRAPHITE.

The manufacture of graphite on a commercial scale from various forms of amorphous carbon is conducted by the International Acheson Graphite Co., of Niagara Falls, which utilizes electric power generated at the Falls. Dr. Acheson patented the process for the manufacture of graphite by the electric furnace in 1896, and its commercial development has been so rapid that at present the output of artificial graphite is greater than the whole production of natural crystalline graphite in the United States.

The conversion appears to take place on a commercial scale only when certain impurities, usually siliceous, aluminous, or ferruginous, are present. These need not form more than 3 per cent of the total, but to obtain the best results should be evenly disseminated through the mass. The explanation of the conversion which has been advanced by Dr. Acheson supposes that the amorphous carbon first unites with the siliceous, ferruginous, or other impurities present to form carbides, which are later decomposed with the formation of graphite and the volatilization of the other constituents. The small amount of impurity required to effect the change is explained by supposing that the transfer becomes progressive, vapors of iron or silicon traversing the entire charge, combining with molecules of amorphous carbon, and then abandoning them in a graphitic state. This explanation is not, however, accepted by all investigators, and recent investigations (3) appear to show that the product obtained in the electric furnace depends fully as much upon the nature of the original carbon used as upon the impurities present.

Anthracite coal carrying small amounts of evenly distributed impurities is used in the manufacture of the ordinary grades. An anthracite with 5.78 per cent ash is said to have yielded a graphite with only 0.03 per cent of ash, the siliceous impurities being volatilized in the process. For obtaining the purest grades of graphite petroleum coke is substituted for anthracite. An important part of the industry at Niagara Falls is the graphitization of rods and bars of amorphous nongraphitic carbon for use mainly as electrodes in electrochemical industries. These bars are made by pressing hot through a die in a hydraulic press a mixture of tar and ground petroleum coke. They suffer very little change in size or form in the process of graphitization. The Acheson furnaces have permanent heads for conducting the current. The walls are of loose-brick construction designed to retain the materials in place while the furnace is in operation; when the furnace is about to be unloaded the walls are easily torn down. Coke and sand are used for insulating. Although several furnaces connect with each electric unit, only one is fired at a time, the others being in process of loading, unloading, cooling, or repair. Furnaces for the production of ordinary bulk graphite are run for 12 to 24 hours and are allowed to cool for about four days, reloading taking place about every five days. The carbon rods and bars for electrodes, etc., must be fired much longer.

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[1] The figures in parentheses refer to the entries under "Select bibliography" on pp. 1106–1112.

Prices for powdered graphite range from 4 cents to as much as 28 cents a pound, according to grade, and for the electrodes, etc., from 10 to 12 cents a pound. Much of the powdered graphite is mixed in proportions varying from 1 to 10 per cent with greases of several degrees of stiffness. A specially treated graphite which will remain suspended in oil is marketed in a concentrated form in gallon equivalents. When 1 gallon equivalent is mixed with oil to make 1 gallon of material the mixture contains 0.25 per cent of graphite.

In spite of the development of the manufacture of graphite by the electric furnace, the demand for the natural product has increased very largely in recent years because of the growth of the iron and steel industry, the largely increased use of copper and its alloys, the increased need for lubricants, and the development of electric machinery which calls for graphitized products.

USES.

The characteristics possessed by graphite and already mentioned make it a mineral of great and increasing industrial importance, but also, as already stated, graphite from any one property is never adapted to all of these uses, its purity and physical character determining its industrial application. One of the oldest and most important applications is in the manufacture of crucibles for use in the steel, brass, and bronze industries, etc. (25). The facts that graphite is nearly pure carbon, is relatively inert chemically, and volatilizes only at high temperatures make it of exceptional value for this purpose. Such crucibles must have good tensile strength, and the poorer the binding quality of the graphite used the larger the quantity of less refractory binding material which must be added to hold the mass together, thus increasing the more fusible constituents of the crucible at the expense of the more refractory and materially decreasing its life. It is for this reason that a fibrous or flaky graphite is used in crucibles, for the interlocking of these flakes or fibers adds to the tensile strength. Ground Ceylon lump graphite is the material most in favor in the United States for making crucibles, although small amounts of American flake graphite are also used. Amorphous graphite has never been successfully utilized in crucible manufacture with the single exception of very small crucibles machined out from manufactured graphite rods or blocks.

Other refractory products such as muffles, stirring rods, dipping cups, skimmers, and nozzles are usually made from materials similar to those used in crucibles, although manufactured graphite products are also on the market for many of these uses and for the preparation of molds for metal casting. Manufactured graphite for such uses is made by treating in the electric furnace amorphous carbon articles previously made up into the desired form. The main use of such graphitized carbon rods and plates is as electrodes in electro-chemical industries. They can be machined, threaded, and cut with ease.

One of the most important uses of graphite is for lubricating. The addition of graphite to oil results in a lower frictional resistance than would be obtained by the use of oil alone. The quantity of oil required for a given service is also reduced and a lighter grade of oil may be employed without decreasing the quality of the lubrication. A small quantity of graphite only is required, and the benefits derived from its use persist long after the application has ceased. In light bearings of machinery where oil can not be used on account of the danger of soiling delicate textiles, graphite can be used alone as a lubricant. Both the amorphous and the crystalline varieties of natural graphite are extensively employed for lubrication, and when used for this purpose should be free from gritty impurities. The percentage of graphite in the better grades of lubricating stock usually exceeds 90 per cent. Lubricating graphite is sometimes marketed as dry flake or powder, but usually as a mixture with oil or grease.

The use of graphite in the manufacture of pencils is probably both its oldest and its best known application. This industry in Germany and England is several centuries old, and many of the modern factories manufacture hundreds of varieties of pencils, yet the percentage of graphite used for this purpose is not large, being undoubtedly less than 10 per cent of the world's production, and one authority estimates it as low as 4 per cent. In this industry the physical character of the graphite is of great importance. Crystalline graphite, however pure, would, if used alone, yield a "lead" that would slip over the paper without leaving more than a faint streak. Furthermore, it is almost impossible to grind the easily cleavable flake graphite into a powder of the fineness and evenness of grain requisite for the better grades of pencils. The better grades of amorphous graphite constitute the bulk of the material used in pencil manufacture. For some of the cheaper pencils only one kind of graphite is used, but the graphite for pencils of the better grades is a careful blend of several kinds. One blend, for example, contains about one-third Ceylon graphite, one-third Bohemian graphite, and one-third Mexican graphite. The Ceylon graphite adds to the smoothness of the "lead"; the Bohemian graphite adds blackness. Graphite when used for pencils is mixed with carefully refined clay, which is usually imported from Germany; no domestic clay has been found entirely suitable for pencil manufacture. The more graphite and the less clay the softer the pencil; the less graphite and the more clay the harder the pencil. The cores of softer pencils are usually made larger than those of the harder ones in order to give them equal tensile strength. For a pencil of medium hardness about one-third clay is commonly used. The wet mixture of clay and graphite is worked and reworked until it is so pliable that it can be looped in coils and even tied in loose knots.

Up to a few years ago every American pencil manufacturer had to import his graphite from Bohemia or Bavaria. About 12 years ago a large deposit of amorphous graphite was discovered in Sonora, Mexico. This proved to be of excellent quality for pencil making and many other uses, and the American pencil trade now derives its supply mainly from this source. Some Mexican graphite is also exported to European pencil manufacturers.

A use which has increased rapidly in importance within the last few years is the manufacture of graphite paint, especially for structural iron and steel work. Much of the graphite used for this purpose is rather impure, the specifications frequently requiring not more than 35 or 40 per cent of graphite in the paint pigment, the remainder being generally siliceous, aluminous, or ferruginous material. Most of the graphite used in paints is of the amorphous variety, but some very fine-grained crystalline material is also employed. Six graphite paints used in tests on the Pennsylvania Railroad bridge at Havre de Grace, Md., showed from 19.16 to 97.80 per cent of graphite in the pigment. Recent tests made in cooperation between the Office of Public Roads of the Department of Agriculture and the Paint Manufacturers' Asociation, for the purpose of determining the relative merits of various paint pigments as preservative coatings for iron and steel, have yielded results of great importance, with which makers and users of graphite paint should be familiar. (17)

Large quantities of amorphous graphite and of finely ground crystalline graphite are used for coating molds in foundries. A high degree of purity, though essential for the finest castings, is not necessary in all graphites used for this purpose; in fact, the presence of siliceous material may sometimes be of positive benefit by causing the graphite to cling or spread better on the face of the mold. Considerable amounts both of amorphous graphite and of finely ground crystalline graphite are used in the manufacture of stove-polishing powders and pastes. Another use of crystalline graphite is as a protective polish for gunpowder and as a packing material for the delicate electric lamp filaments; it is also used in electrotyping and as a filler for dry batteries.

PRODUCTION AND IMPORTS.

NATURAL GRAPHITE.

Production.—As in previous years the bulk of the production of crystalline graphite in 1911 came from New York, Pennsylvania, and Alabama. The quantity of crystalline graphite marketed was notably less than in 1910. This falling off is explained largely by the idleness of the Allen plant, at Quenelda, Ala., during nine months of the year and the idleness of the Acme and Pennsylvania companies in Pennsylvania during the entire year. In New York the Crown Point Graphite Co., which operated in 1910, was idle in 1911.

Amorphous graphite was produced in Colorado, Michigan, Nevada, and Wisconsin and was used mainly for paint pigment and foundry facings. The so-called graphitic slates of Georgia, which are used for fertilizer filler and which contain only from 2 to 15 per cent of carbon, possibly in the form of graphite, have been included in previous reports under the heading of amorphous graphite. Since their content in graphite is small and they are not adapted for any of the uses to which amorphous graphite is usually applied, it is thought best for the future not to consider them as graphite.

Of general interest are the acquisition of the mine and mill of the Allen Graphite Co. at Quenelda, Ala., by the American Flake Graphite Co. of Pennsylvania and the development of a new amorphous graphite mine in Sonora, Mexico, on property adjacent to that of the United States Graphite Co. The company opening this Mexican mine is backed by San Francisco capital and is known as the Crown Graphite Co. Over 1,000 feet of development work is said to have been done on one of the veins, and much of the material is said to run 80 to 85 per cent graphite.

As Ceylon graphite is more extensively used in the United States than any other kind, its deposits are of especial interest to Americans. As much of the literature dealing with them is not readily available the writer has prepared a summary of our knowledge of these deposits which appears in subsequent pages of this report.

Production of natural graphite, 1907–1911.

Years.	Amorphous.		Crystalline.		Total.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Short tons.		*Pounds.*		*Short tons.*	
1907	26,803	$125,821	4,947,840	$171,149	29,277	$296,970
1908	1,443	75,250	2,288,000	132,840	2,587	208,090
1909	5,096	32,238	6,294,400	313,271	8,243	345,509
1910	[a] 1,407	39,710	5,590,592	295,733	4,202	335,443
1911	[a] 1,223	32,415	4,790,000	256,050	3,618	288,465

[a] Exclusive of Georgia graphitic slate.

Imports.—It is significant that during the last three years Korean graphite has been brought into this country in increasing quantities and is proving valuable for many uses to which the amorphous graphite from Mexico is applied. An account of the Korean industry is given on subsequent pages.

The following table shows the countries from which graphite was imported in 1911, arranged according to their relative importance:

Imports of graphite for consumption into the United States, 1911, by countries, in short tons.

Country.	Quantity.	Value.
Ceylon	13,119	$1,132,678
Mexico	3,368	254,060
Canada	2,289	78,196
Japan (mainly from Chosen via Japan)	1,256	18,486
Italy	510	6,242
Austria-Hungary	65	1,139
Germany	48	2,930
Other countries	47	1,998
Total	20,702	1,495,729

The following table gives the statistics of imports for the last five years:

Imports for consumption of graphite into the United States, 1907–1911, in short tons.

Years.	Quantity.	Value.
1907	22,939	$1,777,389
1908	11,456	762,367
1909	21,267	1,854,459
1910	25,235	1,872,592
1911	20,702	1,495,729

WORLD'S PRODUCTION.

The world's production of graphite for the years 1907–1909 was as follows:

World's production of graphite, 1907, 1908, and 1909, in short tons.[a]

Country.	1907		1908		1909	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
United States	29,277	$296,970	2,587	$208,090	8,243	$345,509
Austria	53,013	387,930	48,970	349,118	44,875	320,289
Canada	579	16,000	251	5,565	863	45,999
Ceylon	36,406	2,889,596	28,916	2,593,160	36,056	3,237,751
France	138	1,206	....	....	....	....
Germany	4,409	47,671	5,340	60,264	7,467	64,724
India	2,725	35,949	3,218	69,814	3,508	60,972
Italy	12,125	61,374	14,235	71,758	12,768	71,148
Japan	115	5,222	195	8,592	136	5,290
Mexico	3,530	54,339	1,742	28,426	1,878	25,301
Norway	1,543	14,974	1,192	13,005	....	....
Sweden	36	946	73	2,046	29	779
Queensland	34	965	22	292	....	....
Total	143,930	3,813,142	106,741	3,410,130	115,823	4,177,762

[a] Mines and quarries: General report and statistics for 1909, pt. 4. London.

MANUFACTURED GRAPHITE.

As shown in the following table, the production of manufactured graphite at Niagara Falls, N. Y., was somewhat less than in 1910 and the average price was also somewhat lower. The capacity of the plant is being increased by extensive additions.

Production and value of manufactured graphite, 1907–1911.

Years.	Quantity.	Value.	Average price per pound.
	Pounds.		*Cents.*
1907	6,590,000	$481,239	7.30
1908	7,385,511	502,667	6.80
1909	6,664,017	480,000	7.20
1910	13,149,100	945,000	7.20
1911	10,144,000	664,000	6.55

INDUSTRY BY STATES AND TERRITORIES.

ALABAMA.

The Alabama production, as usual, was all of the crystalline variety. There was a notable decrease in production as compared with 1910, because the Allen Graphite Co., of Quenelda, only operated for the first three months of the year. The mine and mill of this company were taken over during the year by persons associated with the American Flake Graphite Co., of Pennsylvania, and will be operated under the name of the Quenelda Graphite Co. The Ashland Graphite Co., of Ashland, is also undergoing reorganization and a new mill is in process of erection.

The Alabama deposits were described in detail in the report on graphite in 1910 (9).

ALASKA.

Development work was continued during the year on the property of the Alaska Graphite Co., near Port Clarence, Alaska, but no graphite was marketed. Alaskan deposits have been described in earlier Survey reports (61, 83, 84).

CALIFORNIA.

The Dixon Graphite & Milling Co., whose mine was located at Point Arena, in Mendocino County, is reported to be out of business. The material is said to carry only from 8 to 10 per cent of graphite. Some prospecting for graphite was carried on during the year by persons from Los Angeles, about 50 miles north of Los Angeles. Samples sent to the Survey for examination were graphite schist more or less decomposed, in which graphite occurs in small flakes. The material is similar in general to some of the graphite schists of the eastern United States. No California graphite was marketed during 1911.

COLORADO.

In Colorado the Federal Graphite Co., with mine at Turret, Chaffee County, continued to be the only producer. The product, which is amorphous, is milled at Warren, Ohio, and used for paints, foundry facings, etc. The mine was described in the report on graphite in 1909 (8).

GEORGIA.

Georgia produced no material which can properly be described as graphite, but a large amount of slate containing 2 to 15 per cent of carbon, probably in part graphite, was quarried in Bartow County, near Atlanta, and ground for use as a filler and dryer in fertilizers. In previous years the production of this material has been included under the heading of amorphous graphite, but as it is not adapted for any of the purposes for which higher grades of amorphous graphite are used, and as these higher grades are never used as fertilizer filler, it is best for the future not to include this material under the name of graphite.

MASSACHUSETTS.

A graphite deposit occurs near Sturbridge, not far from the Connecticut boundary. No descriptions of the geology of this deposit have been published, and the property has not been worked for many years. Historically, however, the deposit is of unusual interest,[1] since it was not only the first graphite mine worked in the United States, but one of the first mining adventures of any kind in America. In 1644 there was granted to John Winthrop, jr., son of Gov. Winthrop, of Massachusetts, "Ye hill at Tantousq, about 60 miles westward (from Boston), in which the black leade is, and liberty to purchase some land there of the Indians." He made the acquisition doubly sure by purchasing the tract from the Indian inhabitants. Development was not begun until 1658, after Winthrop had interested some Boston men in the project. How long this work was continued or how much graphite was obtained is not known, but several letters to Winthrop from his miners are on record in which they complain of the cost and difficulties of mining, and the work seems to have been soon abandoned. Nothing further was done at the property until 1738, when John Winthrop, nephew of the original owner, again started mining and shipped some of the graphite to England, where it brought about 4 pence a pound. A little mining was done in the summer of 1740, when less than a ton was extracted. Discouraged at the small price received for the material, mining was again abandoned, and there is no record of further development while the property belonged to the Winthrop family. It remained idle until 1828–29, when Frederick Tudor, of Boston, secured possession of the mine and operated it as an adjunct to the manufacture of crucibles. After Mr. Tudor's death, the property remained idle until sold to the Massachusetts Graphite Co. in 1902. It has remained in the possession of this company up to the present time and has been operated occasionally. According to Mr. Haynes, the principal vein of graphite dips at about 70° and has been worked through an open cut some 500 feet in length and 6 feet wide. A tunnel has also been driven to reach the vein at a greater depth.

MICHIGAN.

The Detroit Graphite Co. continued to mine graphitic slate at its quarries at L'Anse, in Baraga County, Mich., for use in paint manufacture. Similar material was also mined by the Northern Graphite Works, with mill at L'Anse and mine 9 miles from L'Anse. This company has taken over the mill formerly used by the Hathaway Graphite Co. The output was small, and the operation is still largely experimental. The material is carefully picked, crushed, ground, air floated, and bolted through silk to a fineness of about 200 mesh.

MONTANA.

The only graphite property operated in Montana during the year was that of the Crystal Graphite Co., near Dillon, whose principal mine is described below in detail. Some development work was done, but no important amount of graphite was marketed.

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[1] Haynes, G. H., The tale of Tantiusques, an early mining venture in Massachusetts; Proc. Am. Antiquar. Soc., Ann. Mtg., Oct. 31, 1901.

The mine of the Crystal Graphite Co. near Dillon is of more than ordinary interest because in its geologic relations and in the character of its graphite it shows some similarities to the famous deposits of Ceylon. Unfortunately, the quantity of high-grade graphite yet discovered is too small to form the basis of an industry like that of Ceylon, but there seems good prospect of the development of one paying mine. The principal workings on the property are located about 9 miles southeast of Dillon (16 miles by road), at the south end of the Ruby Range. The property is within the area of the Dillon topographic sheet of the United States Geological Survey. The mine occupies what is known as Crown Point at an elevation of 9,000 feet, and a good wagon road leads to the mine cabins, within a mile of the mine. From there to the mine the steep mountains must be climbed on foot. Without great expense a wagon road could be constructed to the mine or the graphite could be transported on pack animals over the steeper part of the trail. The mine is located on the ridge between Timber and Van Camp gulches.

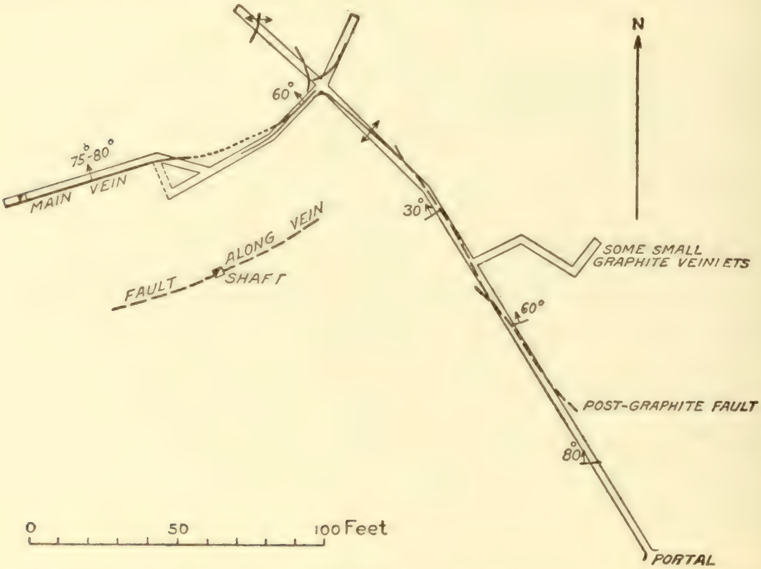

FIGURE 9.—Plan of main workings, Crystal Graphite Co., near Dillon, Mont.

According to Winchell (91, 92) the rocks exposed in the Ruby Range are chiefly the thick limestone series of the Paleozoic in Montana. The rocks immediately associated with the graphite deposits are limestones and quartzites, apparently of Paleozoic age, which overlie quartz schists and slates that are probably pre-Cambrian. All are intruded by granite and pegmatite, and certain rocks of contact-metamorphic origin are developed as a result of this intrusion.

The principal workings are shown in figure 9, the graphite veins being indicated in heavy, solid black lines. The strike of the rocks near the tunnel is variable from N. 5° E. to N. 60° E. with dips of 30° to 60° NW. The first 160 feet of the tunnel may be regarded as crosscut, but the workings beyond follow in part graphite veins. The wall rocks where exposed are pegmatite, quartz schist, and garnetiferous mica schist. As shown in figure 9, in the first 160 feet the tunnel encounters several small graphite veins, but the maximum width of graphite exposed in any of them is only 2 inches, so that they are not workable. The noteworthy feature of this part of the tunnel is the fault plane shown on the map by a broken line. This was formed later than the graphite, for it cuts the graphite veinlets. It carries much gouge but no graphite except a little which has been dragged out from the veins. At 160 feet from the portal one of the main graphite veins of the mine is encountered and is followed by the tunnel for 30 feet to a point where it turns sharply west. This vein is commonly vertical, but where it turns the dip shifts to 60° N. In places it shows 4 inches of very pure graphite, and in one place the graphite is reported to be 6 inches wide. Beyond the turn this vein merges with the main vein of the mine which is developed by the 120-foot northeast to southwest drift shown on the map.

The main vein shows from 2 to 8 inches of very pure graphite. It dips from 60° to 80° N. Near the main tunnel where it shows 4 inches of pure graphite it is in sharp contact with walls of granite-pegmatite which near the vein contain scattered graphite flakes up to one-fourth of an inch in size. The graphite has been fractured by postmineral movements along the vein and slickensides are developed in both the graphite and the wall rocks.

One of the best exposures in the mine is 10 feet from the face of the main tunnel where a graphite vein is shown in cross section. The wall rock here is altered quartz schist, in places becoming micaceous, and is traversed by a nearly vertical fracture zone along which graphite has been deposited. The vein is about 2 feet wide and consists of an irregular network of graphite veinlets inclosing many sharp-walled schist fragments. The graphite forms about half of the vein material and the veinlets locally unite to form irregular bunches. The south wall is fairly regular, but the north wall is ragged and is penetrated by irregular apophyses from the main graphite mass.

It is evident from this description that the graphite of this mine forms rather irregular veins deposited along fracture planes and more or less broken up by later fracturing.

In comparing the graphite from these veins with that from Ceylon it must be remembered that the workings are shallow and that surface alteration has produced certain changes which will be less noticeable when greater depths have been reached. For example, (1) the luster of this graphite, even when the lumps have been polished or rubbed up, is much less brilliant than that of most of the Ceylon material; (2) thin films of iron oxide occur along parting planes between some of the graphite plates; and (3) the graphite is softer than that from Ceylon and grinds up more readily though still yielding a flaky product. These differences will decrease somewhat with depth, but the product will probably never be entirely similar to that from Ceylon.

When broken between the fingers the graphite separates into splinters which are roughly spearhead shaped. Truly fibrous varieties, such as the " needle lump " which occasionally occurs in Ceylon, were not observed at Dillon.

The absence of the cheap labor available in Ceylon for sorting, rubbing up, etc., is in Montana a handicap which may be offset in a measure by the employment of modern and expeditious methods of mining. If the graphite is steadily produced, a market for use in crucibles might be built up, and it should be excellently adapted for lubricating.

There are numerous other prospect tunnels in this vicinity which show more or less graphite, but none of them are of any commercial promise.

NEVADA.

The Black Lead Mining Co., of Carson City, continued operation during 1911. The material mined is amorphous and is said to contain about 30 per cent of graphite. It is ground in burr mills and used principally as a pigment in paint.

NEW YORK.

The companies producing natural graphite in New York in 1911 were the Joseph Dixon Crucible Co., the Empire Graphite Co., and the Sacandaga Graphite Co. The last is a successor to the Glen Falls Graphite Co. Development work and drilling was continued on the Faxon property, adjacent to that of the Joseph Dixon Crucible Co. Crystalline graphite, some of it occurring in limestone, has been found in the town of Putnam, in Washington County, on the east side of Lake George. Some development work has been done and experimental mill runs were made. The plant of the Crown Point Graphite Co. has been closed since the fall of 1910. The New York production showed a decrease of about 63 tons in quantity and of $21,750 in value as compared with 1910.

NORTH CAROLINA.

Mr. Charles Rennie, of Franklin, N. C., reports the occurrence of flake graphite 4 miles west of Franklin. A few tons were shipped for treatment to the Federal Graphite Co. at Warren, Ohio.

PENNSYLVANIA.

The Pettinos Bros.' plant at Byers, which was closed during 1910, was in operation again during most of 1911. The plant of the Acme Graphite Co., which a few years ago acquired the properties of the Continental Graphite Co. and the Pennsylvania Graphite Co. at Byers, was closed during all of 1911. The Acme Co. is now out of business, the old Continental mine having been sold in January, 1912, to New York persons, and the Pennsylvania plant reverting to its former owners. The American Flake Graphite Co. continued to be an important producer. It did not purchase the property of the Federal Carbon Co., as was stated in the report for 1910, but has recently acquired the property of the Allen Graphite Co. at Quenelda, Ala. The Chester Graphite Co., Chester Springs, has ceased to operate the mine and mill of the New Philadelphia Graphite Co., which has reverted to the former owners. During 1911 the Chester Graphite Co. did no mining but milled the partly finished stock of other producers at a new mill across the road from its old mill. The Girard Graphite Co. has sold no material since 1909 and most of the machinery has been removed from its mill. The Eynon-Just Mining Co. of Philadelphia mined some material from French Creek in Coventry and have remodeled a mill at that place. The Rock Graphite Mining & Manufacturing Co., successor to the Sterling Graphite Co., owning a mine north of Chester Springs, did not operate during the year. The Pennsylvania graphite deposits have been described in detail in a preceding Survey report (8).

WISCONSIN.

The only graphite company operating in Wisconsin during the year was the Wisconsin Graphite Co., having a mill near Stevens Point and a mine about 2 miles northwest of Junction City. The mine is a narrow open pit about 300 feet long from north to south, from the bottom of which a shaft inclined about 30° W. has been sunk. There are three levels in the underground workings. The underground workings were not accessible and little could be learned of the size or shape of the workable body of rock. It appears to strike nearly north and south and to dip gently to the west. The material mined is hauled to Junction City and transported by rail to the company's mill on Big Clover River south of Stevens Point. The product is crushed, ground in tube mills, and air floated, and is used mainly as a pigment. The pulverized product sells at 1 to 2 cents a pound.

The mine of the Pioneer Graphite Co. is about one-eighth of a mile north of that of the Wisconsin Graphite Co. It has been idle since 1909, when the mill was destroyed by fire. An open pit 100 feet long from north to south and 40 feet wide is now filled with water. A shaft, said to be 86 feet deep, connects with several levels, and about 250 tons of material in all has been mined.

The rock mined at both of these properties is a black slate or shale of hackly fracture, which has in places been sheared with the development of a schistose structure and glossy slickensided surfaces. Occasional small seams of quartz and pyrite traverse this rock. A rock associated with the black rock is bright terra cotta colored and is evidently very rich in iron oxide. Some of this rock has also been used as a pigment in paint.

WYOMING.

The following paragraph in regard to the Wyoming graphite deposits is quoted from a recent bulletin by the State geologist:[1]

> This mineral [graphite] is found in Laramie, Albany, Carbon, and Fremont counties, the carbon content, as shown by analyses of samples, varying from 10 to 60 per cent. In Albany County there is a large district known as Plumbago Canyon, where there are a great many deposits of graphite. In Fremont County a deposite of graphite, which is said to be extensive and very pure, occurs near Miners Delight. The graphite found in the State is mostly of the amorphous variety and suitable for paint and foundry facings.

Graphite deposits in the Haystack Hills have been described in previous reports of this Survey (5).

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[1] Jamison, C. E., Mineral resources of Wyoming: Bull. I, ser. B, 1911, p. 34.

MARKETS AND PRICES.

The prices paid by crucible makers and others for Ceylon graphite during 1911 were approximately as follows:

Prices of Ceylon graphite at New York City in 1911.

	Cents per pound.		Cents per pound.
Ordinary lump:		Dust:	
Best	8¼–9	Best	3½–4
Medium	7 –8	Medium	2¾–3¼
Poor	6 –7	Poor	2 –2½
Chip:		Flying dust:	
Best	5¼–5¾	Best	3¼–3½
Medium	4 –5	Medium	2 –2½
Poor	3½–4	Poor	1½

The reports on domestic market conditions were somewhat divergent, even among graphite producers in the same district. This fact indicates the extent to which success in the domestic graphite industry is dependent on the processes of treatment adopted and the cleanness of the product obtained. The production being sporadic and of uneven grade, regular markets have been established only in a few cases. By nearly all producers market conditions were reported as poor or fair. The prices for American flake graphite were extremely variable, but the following figures will give some idea of their range. In general they were somewhat lower than in 1910.

Prices for domestic flake graphite in 1911, f. o. b. mills.

	Cents per pound.
Best crucible flake	5 –7
Medium grade flake	4 –6
Inferior grade flake	2½–4
Dust	¾–2½

Amorphous graphite varies greatly in price according to texture and percentage of carbon. Crude amorphous graphite from Mexico can be purchased in New York City for about $30 a ton.

According to importers' quotations in March, 1912, Chosen (Korean) amorphous graphite can be purchased in New York City at $25.50 to $26 per ton, c. i. f., in large lots. This material is guaranteed to run at least 81 per cent carbon.

FOREIGN DEPOSITS.

CEYLON.

The graphite deposits of Ceylon are of especial interest to Americans because most of the graphite used in this country comes from that island and because the United States has for many years been the largest consumer of the Ceylon material. Much has been printed in regard to these deposits, but it is widely scattered through publications in various languages which are not readily accessible to the American public. The writer has, therefore, summarized the more important facts which are on record, with apologies for any errors which may have crept in on account of his lack of personal knowledge of the island.

Although their existence was known in early times and mentioned in print as early as 1681, the graphite deposits of Ceylon were not exploited until some time between 1820 and 1830. Joseph Dixon is reported to have imported a small quantity into the United States in 1829, but it was not until 1834 that the industry assumed any commercial importance. From that time to this, as a result of the growth of metallurgical industries and the resulting demand for refractory materials, the industry has developed rapidly, until at present graphite is subordinate in value only to tea and the products of the coconut palm among the exports from the island. Figure 10 shows the production of graphite in Ceylon from 1834 to 1910.

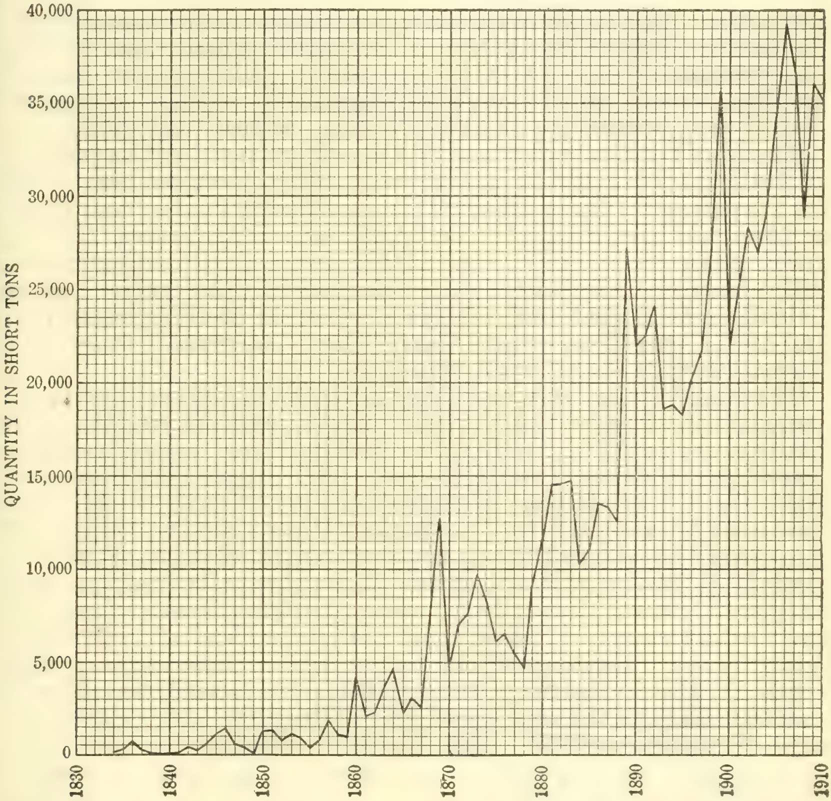

FIGURE 10.—Diagram showing quantity of graphite (plumbago) exported from Ceylon from 1834–1910.

From the early days of the industry up to 1901, Great Britain consumed more Ceylon graphite than any other country. Since 1901 the United States has assumed the first place, with Great Britain second until 1909, when Germany took second place. The distribution of graphite exports for one year in each of these trade periods is given within.

Exports of graphite from Ceylon, in short tons.

Destination.	1885	1902	1911
Great Britain	7,670	7,586	5,794
United States	3,074	15,244	12,062
Germany	67	3,833	8,572
Belgium	....	1,096	3,108
Other countries	187	453	695
Total	10,998	28,212	30,231

It is interesting to note that an American firm, Pettinos Bros., of Bethlehem, Pa., is one of the principal exporters of Ceylon graphite. With the exception of the operations of this firm and of a limited amount of graphite mining done on tea estates, the industry is in the hands of native Sinhalese. It has been estimated that the various processes of mining, sorting, "curing," packing, and shipping graphite, as well as the making of barrels in which it is exported, provide employment for about 50,000 men, women, and children.

The island of Ceylon is just off the southern point of the peninsula of British India, the channel between being nowhere deep enough for the passage of large ships. The island is more or less pear shaped in form, and has a length from north to south of about 275 miles and a maximum width of about 135 miles. A railroad extends the entire length of the island, with branches into the central interior. Colombo, the capital and principal seaport, is on the western coast, and is the port from which nearly all of the graphite is shipped. A small quantity is shipped from Galle.

The island of Ceylon may be divided into two natural provinces—a mountainous region of crystalline rocks, which forms the southwestern part of the island, and a lowland area made up of coral limestones and marine sands of much later origin to the north and east. In the mountainous province there are 10 peaks which rise to elevations of over 7,000 feet, the highest being 8,296 feet. This province covers about one-fifth of the area of the island, and in it are located all the graphite deposits. The principal mines, as shown in figure 11, are in the southern, western, and northwestern provinces and in the Province of Sabaragamuwa at distances of 5 to 50 miles from the sea. The deepest and best graphite mines are near Kurunegale, in the northwest province; others are located near Kegalla, about 15 miles to the south, and near Ratnapura, both in the Province of Sabaragamuwa. The relative importance of the various districts may be judged from the following data, taken from the Ceylon Blue Book for 1909:

Statistics of graphite industry in Ceylon in 1909.

Province.	District.	Number of graphite pits.	Output in long tons.
Sabaragamuwa	Ratnapura	188	7,351
	Kegalla	53	4,041
Southern	Galle	170	5,026
	Matara	73	....
Western	....	248	4,763
Northwestern	Kurunegale	38	2,432
Central	Kandy	....	394
Total	....	770	24,007

The most abundant rocks of the mountainous crystalline area are gneisses (true gneisses and granulites of the European geologists) of both light (acidic) and dark (basic) varieties. The foliation of these rocks strikes in general northwest and southeast, and has caused the northwest-southeast trending valleys and ridges which form a conspicuous feature of the topograph of the hilly province.

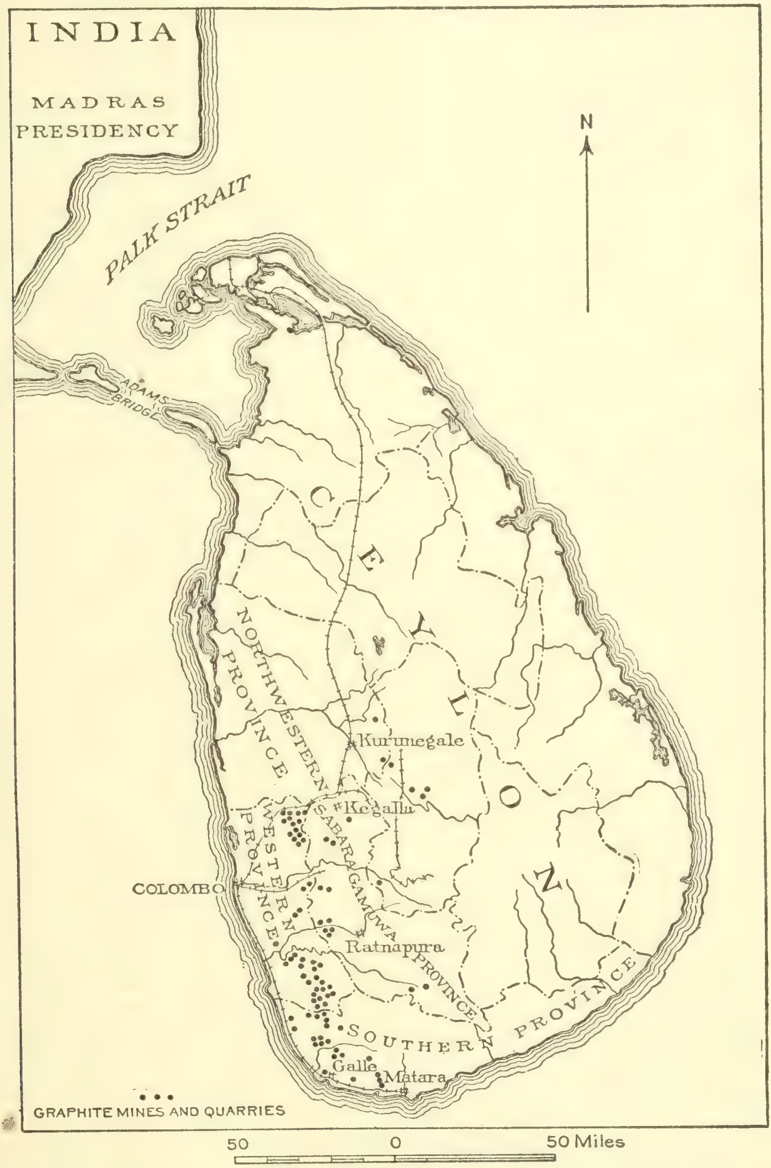
INDIA
MADRAS PRESIDENCY
PALK STRAIT
N
ADAMS BRIDGE
CEYLON
NORTHWESTERN PROVINCE
WESTERN PROVINCE
SABARAGAMUWA PROVINCE
SOUTHERN PROVINCE
Kurunegale
Kegalla
COLOMBO
Ratnapura
Galle
Matara
• • • GRAPHITE MINES AND QUARRIES
50
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FIGURE 11.—Map of Ceylon, showing location of graphite mines and quarries. [Adapted from Stonier.]

Conspicuous jointing nearly at right angles to the foliation has determined the position of many of the smaller valleys.

Gneisses which are nearly pure quartz grade into others which contain small quantities of feldspar, garnet, and mica. Other types consist mainly of quartz and orthoclase feldspar, with garnet and biotite as accessory, and zircon, apatite, and graphite as occasional, constituents. More basic types are composed mainly of labradorite feldspar with either pyroxene (hypersthene) or hornblende. The most basic varieties usually form lenticles or pinching bands among the acidic and medium types and show as their principal constituents hypersthene, augite, garnet, basic plagioclase feldspar, etc.

Intimately interbanded with the commoner types of gneiss in bands varying from a few inches to hundreds of yards in width are crystalline limestones, many of which are dolomitic. The origin of the gneisses is not certainly known, but the presence of beds of crystalline limestone will be regarded by most geologists as proof that a part of them at least are metamorphosed sediments. The presence along certain contacts between limestone and gneiss of rocks composed mainly of diopside, mica (phlogopite, etc.), amphibole, scapolite, spinel, sphene, and calcite, with occasional feldspar, marcasite, etc., is, on the other hand, suggestive of contact metamorphism and hence of an igneous origin for certain of the gneisses.

Other rocks from the southwestern part of the island, described under the name Galle group, are also rich in lime-silicate minerals. In addition to quartz, green pyroxene, and feldspar they contain wollastonite, scapolite, and sphene, and sometimes apatite, garnet, zircon, and pyrite, and they show conspicuous banding. Microscopic sections show that the graphite crystallized at the same time as the other rock minerals. The association of minerals present in them is certainly suggestive of metamorphic origin. Certain rocks of the Galle group are massive and consist mainly of quartz, orthoclase, and wollastonite. They form irregular patches or veinlike masses which may cut across the trend of the banded types, and are often exceedingly coarse, containing wollastonite individuals up to 36 by 15 inches, quartz up to 11 by 5½ inches, and orthoclase crystals up to 24 inches in diameter. The rocks are perhaps to be regarded as true pegmatites that have absorbed lime from sediments with which the magma has come in contact. The writer has observed wollastonite at Apex, Colo., in an abnormal phase of a monzonite porphyry intrusive in schists of sedimentary origin.[1]

In the absence of any fossils, the age of the gneisses and associated crystalline limestones of Ceylon can only be inferred from the relations observed on the neighboring mainland in India. There, as we proceed southward, the Paleozoic rocks disappear and are succeeded by rocks believed to be pre-Cambrian, which are closely similar to the crystalline rocks of Ceylon.

The groundmass of the foliated rocks has been intruded by massive igneous rocks of both acidic and basic varieties. Prominent among the acidic varieties are zircon granite and granite-pegmatites. The granite consists mainly of quartz, orthoclase, acidic plagioclase feldspar, and biotite, with zircon, ilmenite, and apatite as accessories. Clear, colored zircons from this granite found in placers are sold as gems. The pegmatites consist essentially of orthoclase and quartz, often in graphic intergrowth, and mica or hornblende, or both, and may transgress or parallel the foliation planes of the gneisses. Allanite, apatite, ilmenite, tourmaline, and uraninite are sometimes present.

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[1] Bastin, E. S., and Hill, J. M. The Evergreen copper mine, Colorado; Econ. Geology, vol. 6, 1911, p. 471.

The basic varieties of igneous rocks include pyroxenites of several varieties. The relationship of some of these to the gneisses leaves no doubt of their intrusive character, but the descriptions lead one to suspect that truly intrusive pyroxenites have not always been differentiated from pyroxenic rocks of metamorphic origin occurring as nodular aggregates in the crystalline limestone or forming contact zones between limestones and gneisses.

In regard to the occurrence of the graphite it has already been seen that it is present locally in small amounts disseminated in the crystalline limestones and some of the gneisses. The commercially important deposits, however, are all veinlike in character and were deposited along fracture planes in the rocks. They were thus formed distinctly later than the rocks which they traverse. In most of the graphite districts the main veins parallel the foliation planes of the gneisses, thus striking northwest and southeast. In the Kurunegale district, on the other hand, the principal veins strike northeast and southwest parallel to a system of joint fractures. In any pit or series of pits there is usually a single main vein or several parallel veins following one of these directions of fracturing and sending off minor veins or stringers along the less prominent set of fractures. In some places the extent of the veins along their trend is so slight that they may be more correctly described as lenses. In other places veins of considerable width may contract to mere seams only to widen again when followed farther. The width of the veins varies from less than an eighth of an inch to several feet, and some as narrow as 2 or 3 inches are worked. The walls are usually sharply defined, and the bordering rock is not impregnated with graphite to a distance of more than half an inch from the veins.

In small veins the graphite usually forms an aggregate of parallel platy needles set at right angles to the vein wall. In the larger veins most of the graphite shows a coarse platy structure, though the needle-like structures may be developed in a band from a few millimeters to 2 or 3 centimeters across next the walls or next masses of wall rocks inclosed in the vein. The needle-like aggregates are in high favor commercially because of their highly fibrous structure and are known as "needle lump." Spherulitic aggregates of graphite plates are of occasional occurrence.

Usually the veins consist almost entirely of graphite but sometimes other minerals occur in important amounts. Pyrite is almost always present either disseminated between the individual flakes or needles or concentrated in a more or less definite band in the central portion of the vein. Occasionally a pyrite crystal is penetrated by graphite flakes. Quartz, usually milky, often forms a part of the vein, sometimes occurring as a central band. In a few places rosettes of graphite flakes occur in the quartz, and in other places quartz grains lie between flakes of graphite. Quartz and pyrite are the only accessory minerals which are nearly always present, but occasional minerals are biotite, orthoclase feldspar, pyroxene (usually augite apatite, allanite, and rutile; the last is sometimes developed alon cleavage planes in the graphite crystals. In one mine a remarkab cavity or "vug" was encountered which was about 15 feet hig more than a yard wide, and oval in section. Its walls were line with flaky graphite, and similar material filled its lower portion. I some of the graphite veins slight movements subsequent to thei formation have bent the graphite flakes or crushed them to an earth mass and developed slickensided fracture surfaces.

The graphite is mined either from open pits or through vertica shafts connecting with underground workings. The majority o mines are not deeper than 100 feet, though a few go as deep as 40 or 500 feet. On account of the heavy rainfall water is one of th chief obstacles in deep mining. In a few mines steam pumps an hoists are employed, but as a rule the mining methods are still crude the acme of mechanical ingenuity being reached in a windlass operated by five or six men for hoisting the graphite in a sort of tub The workmen usually ascend and descend by means of rough wooden ladders, tied with jungle ropes and rendered exceedingly slippery by the graphite dust and water.

The mineral as it comes from the pits may contain as much as 50 per cent of impurities, mostly in the form of quartz and wall rock It is conveyed in bags to a dressing shed, where it is picked over and the impurities reduced to 5 or 10 per cent. It is then packed in barrels for transportation to Colombo or Galle. At these ports it is unpacked and submitted to further treatment known as "curing." The graphite merchants have fenced yards or "compounds" for the final preparation of the graphite for the market. In the methods of "curing" there is some diversity, but the first step is usually to set aside the large lumps and to pass the remainder through stationary screens of several different sizes of mesh. The large lumps and the screened pieces are then broken with small hatchets by Sinhalese women to remove the coarser impurities, such as quartz, and are then rubbed up by hand on a piece of wet burlap and finally on a piece of screening to give them a polish. Finally, various grades coming from several mines or differing in size or texture are blended to meet the requirements of purchasers, a process requiring skill and long experience.

The poorer material is usually beaten to a powder with wooden mauls or with beaters shaped like a rolling pin, and is then sorted into different grades. In some establishments the impure grades are washed in a tub or pit. In this process the mineral is placed in saucer-shaped baskets and by a circular "panning" motion of the immersed baskets the graphite particles are thrown off into the pit, while the heavier impurities, especially pyrite, remain behind. To separate the very fine material, the powdered graphite is placed in a basket with somewhat the shape of a large dustpan. The contents of the basket are thrown into the air, and the heavier particles fall back into the basket, while the finer material is blown forward and falls on the floor.

ORIGIN OF THE GRAPHITE VEINS.

Many and varied theories have been proposed to account for the origin of the Ceylon and similar deposits, but none have proved wholly satisfactory. Our knowledge of the deposits is, however, sufficiently definite to enable us to reject certain theories. The deposits are not metamorphosed interbedded coal, since they form irregular vein systems often cutting across the foliation of the inclosing rocks; on the other hand, it is perfectly clear that the graphite was deposited along irregular fracture planes. Any theory of origin through lateral secretion from the wall rocks is untenable because of the extreme sharpness of the vein walls and the scarcity or absence of graphite in the wall rocks. The suggestion that they represent fissures filled with asphalt or other carbonaceous material which was later metamorphosed into graphite is untenable because in Ceylon and in other localities where such veins occur they are themselves younger than any regional metamorphism or igneous intrusion capable of affecting such a change. Thus both in Ceylon and at Dillon, Mont., the veins cut sharply through the schists and gneisses and the youngest of the igneous rocks with which they are associated.

It seems necessary to accept the only remaining hypothesis—that of deposition from some sort of a solution penetrating along fracture planes in the rocks. In regard to the origin and nature of such solutions and the temperature and pressure conditions under which graphite was deposited from them, practically nothing is known, although speculations on the subject have been numerous. Many of these speculations are based upon doubtful analogies between the artificial formation of graphite and its origin in nature. Prominent among these hypotheses are the following: (1) The solutions were mainly carbon vapor which sublimed with the formation of graphite; (2) the solutions contained metallic carbides which decomposed with the formation of graphite;[1] (3) the solutions were rich in hydrocarbons which yielded graphite on decomposition;[2] (4) the solutions carried oxides of carbon and probably also cyanogen compounds;[3] (5) the solutions carried hydrogen and oxides of carbon which reacted with the formation of graphite and water. The relative merits of these various views have been ably discussed by Winchell in his article already cited,[4] to which the reader is referred for further details.

The fact that geologists have indulged in so many and so varied speculations in regard to the origin of the vein deposits of graphite might lead one to infer that the problem could not be reached by the trustworthy methods of field observation and laboratory experiment. In the writer's opinion this is not true. Field studies of the Ceylon deposits and of graphite vein deposits elsewhere[5] have already proved suggestive by showing that the veins are associated with phenomena of igneous (or contact) metamorphism and may themselves have been formed during the last stages of such metamorphism. Although the veins cut the associated igneous rocks and contact metamorphic rocks, they carry occasional crystals of the minerals which characterize the contact-metamorphic rocks, and the latter are usually highly graphitic. A genetic connection between the veins and the contact metamorphic phenomena is therefore highly probable. More detailed field study of the Ceylon deposits and of the little-known vein deposits of Buckingham, Quebec, should throw much light on this important point.

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[3] Weinschenck, E., Abhandl. K. bayer. Akad. Wiss., vol. 21, pt. 2, 1901, p. 281.

[4] Winchell, A. N., Econ. Geology, vol. 6, 1911, pp. 220–230.

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The most important clues to the origin of the graphite veins will probably be furnished by a study of the other minerals which occur in small amounts in the veins. The relations of some of these minerals to the graphite show that they are contemporaneous crystallizations, but closer studies of their exact mode of association are needed in most cases. Something is now known of the stability ranges of two of the most abundant accessory minerals in the Ceylon veins, quartz [1] and pyrite [2] and laboratory experimentation is likely soon to add greatly to our knowledge. By an application of the Wright and Larsen criteria the writer has already shown that quartz intercrystallized with graphite in a contact metamorphic zone was formed at temperatures below 575° C., and similar tests could probably be applied to the quartz of graphite veins.

In conclusion, no theory of the origin of graphite veins can be satisfactory unless it takes into account not only the graphite but the accessory minerals, quartz, pyrite, and numerous silicates which are commonly present in these veins. Their presence imposes certain limitations which must be reckoned with.

LITERATURE ON CEYLON GRAPHITE.

Much of the information which has been published in regard to the graphite deposits of Ceylon is in the form of careful mineralogical descriptions of Ceylon minerals in European museums. Nos. I, O, and S of the following list are the most important papers of this character.

For direct field observations the excellent writings of A. K. Coomaraswamy, for several years in charge of the Mineralogical Survey of Ceylon, and of his associate, James Parsons, are of first importance (Nos. A to H). Some field data have also been contributed by J. Walther (R).

The latest information in regard to the mining of graphite and its preparation for the market has been furnished by G. A. Stonier (P).

Annual figures, showing the quantity and value of the graphite exported and the countries to which it goes, are published in the Ceylon Government Blue Book.

A. Coomaraswamy, A. K., On Ceylon rocks and graphite: Quart. Jour. Geol. Soc., vol. 56, 1900, pp. 590 et seq. A preliminary description of certain rocks and graphite deposits of Ceylon. Material mostly embodied in revised form in later writings by the same author.

B. ——— The crystalline limestones of Ceylon: Quart. Jour. Geol. Soc., vol. 58, 1902, pp. 399–422, 2 plates. Describes the distribution of the crystalline limestones, their accessory minerals, and their contact relationships with the gneisses (granulites).

C. ——— Wollastonite-scapolite gneisses of Ceylon: Quart. Jour. Geol. Soc., vol. 58, 1902, pp. 680–689, map.

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E. ——— The Balangoda group: Geol. Mag., Decade V, vol. 1, 1904, pp. 418–422. Describes occurrences of granite and related pegmatite in Ceylon.

F. ——— Intrusive pyroxenites, mica pyroxenites, and mica rocks in the Charnockite series or granulites in Ceylon: Geol. Mag., Decade V, vol. 2, 1905, pp. 363–369.

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H. Coomaraswamy, A. K., and Parsons, James, Ceylon administration reports: Mineralogical Survey, 1903, pp. L 6–8. Describes methods of working the graphite mines and gives details of several properties. 1905, pp. E 2–4. Describes the mode of occurrence of graphite in Ceylon, discusses its origin, and briefly describes a number of properties. 4 figures. 1906, p. E 5. Description and maps of graphite mines near Laxapana. Bibliography of Ceylon geology. 1908. Devotes one-half page to the distribution of graphite in Ceylon and gives brief notes on some mines in the Kurunegale district.

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S. Weinschenk, E., Die Graphitlagerstätten der Insel Ceylon: Abhandl. K. bayer, Akad. Wiss., vol. 21, pt. 2, 1901, p. 281 et seq.

T. ——— Mémoire sur l'histoire géologique du graphite: Cong. Géol. Internatl., Compt. Rend., Paris, 1900, pp. 447–457. Summarizes the essential characteristics of the graphite deposits of Ceylon and important deposits elsewhere and emphasizes their diversity in origin.

CHOSEN (KOREA).

The following information in regard to the graphite deposits of Chosen (Korea) is taken from a private report prepared in 1909 and placed at the writer's disposal through the courtesy of Mr. Charles Pettinos.

The existence of large deposits of graphite in Chosen has long been known, but no attempt has been made to develop them until within the last few years, the first mention of graphite in the Chosen customs returns being in 1903, although sample shipments had been made before that time. Graphite is known to occur in all the provinces, but appears to be most abundant in the province of Kyeng-Sang, which is nearest to Japan, in Chung-Cheng, one of the western provinces, and in the northern province of Pyeng-an. In northern Kyeng-Sang the graphite is interbedded with gneiss. Up to June, 1909, sixty-five mining rights had been granted under the Chosen laws for the mining of graphite and over forty more were pending.

In 1909 there were five producing mines in Chosen, all operated by Japanese firms. The first of these mines is situated in the northern part of Chung-Cheng province, not far from Whang-gan station on the Seoul Fu-San Railway, over which the product is shipped to Fu-San.

The second mine is not far from the first in the northern part of the province of Kyeng-Sang. The graphite from this mine is transported by river to another station on the Seoul Fu-San Railway. Both of these mines are controlled by the same company which employs in them about 30 Japanese and 100 Koreans.

The other three productive mines are located in close proximity to one another in the northern customs district of Gen-San and employ about 345 Koreans and 32 Japanese. Transport is costly, being affected partly by oxcarts, partly by river boats, and partly by junks to the port of Gen-San.

An American firm of Seoul is investigating several graphite deposits and has done considerable development work on a property on the east cost about midway between Fu-San and Gen-San. The graphite can be transported by junks to Gen-San at small cost.

All the deposits mentioned above are amorphous graphite. Nothing is published concerning their geologic relations or origin, but a report on them by the Japanese Government is in process of preparation. Some of them are said, however, to be of large size and easily mined. The percentage of carbon in the material which has been shipped is said to vary from 60 to 85.

Crystalline graphite is also known to occur in Chosen and one property in Pyeng-an province, northern Chosen, is being investigated. Samples are similar to the graphite of Ceylon, but no information is available in regard to the size or extent of the deposits.

The exports of graphite from the ports of Fu-San and Gen-San, which includes practically the whole Chosen output, are as follows:

Exports of graphite from Chosen (Korea), 1906–1908.

	Long tons.
1906	733
1907	1, 154
1908	6, 455

Most of the Chosen graphite which has gone to Europe or America has been shipped from Japanese ports. It can be laid down at these ports at a cost of from $10 to $13 per long ton. Considerable quantities of Chosen graphite are now being utilized in the United States, where it comes into competition with the amorphous graphite imported from Mexico. The quantity of Chosen graphite imported into the United States in 1911 was probably in the neighborhood of 2,000 long tons.

CUBA.

A company has been organized in the Isle of Pines for the exploitation of a graphite deposit. The material is said to contain over 85 per cent graphite.

LITERATURE.

NEW PUBLICATIONS.

The principal publications dealing with graphite which have appeared in English during the year are the following: An article, by Alexander N. Winchell (91, 92) on the graphite deposits near Dillon, Mont., in which an interesting theory to account for their origin is presented; an article, by W. C. Arsen (3), dealing with the conditions under which graphite may be made artificially. This paper by Arsen is of much interest, since it throws doubt upon the widely accepted belief that the presence of small amounts of impurities is essential to the transformation from ordinary carbon to graphite. Both of these papers are abstracted in the following bibliography, to which the reader is referred for further information.

The best general treatise on the occurrence, methods of treatment, and uses of graphite is that by Fritz Cirkel, listed as No. 16 of the bibliography. The best treatise on the geologic occurrence of graphite is that by Dr. Stützer, listed as No. 77 of the bibliography. This summarizes the geology of the more important and best-known deposits of the world, but only touches briefly on uses and methods of treatment. The book is in German.

The literature dealing with graphite is voluminous and contains many abstracts and quotations. The following list is selected, so far as possible, to avoid duplication and yet to convey all the important information relative to the occurrence and production of the mineral in the United States. Under each reference the general scope of the paper is described, and attention is directed to its most important features. Canadian publications are not listed unless they are of general interest or include mention of United States deposits. For references to the voluminous Canadian literature and many foreign publications the reader is referred to the monograph by Fritz Cirkel, already referred to.

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[1] The numerals given in this index are the numbers prefixed to the entries in the bibliography, pp. 1106–1112.

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2. ——— Discussion of artificial graphite: Mineral Industry, vol. 8, 1899, pp. 351, 352.

3. Arsen, W. C., Transformation of other forms of carbon into graphite: Trans. Am. Electro-Chem. Soc., vol. 20, 1911, pp. 105–119. Discusses experiments by the author and others bearing upon the question whether the transformation of ordinary carbon into graphite can take place by simple heating or only in the presence of certain impurities, which act as catalytic agents. In the author's experiments all samples were fired in a small tube furnace for 15 minutes at temperatures of approximately 3,000° to 3,300° C. Comparative tests were made of various forms of carbon when pure and when mixed with 5 to 10 per cent of impurities. The presence of impurities seemed in most cases to retard rather than to accelerate the conversion to graphite. The character of the carbon used appeared to be important, some forms, such as petroleum coke, being readily converted, while others, such as lampblack, were not graphitized. The author suggests that graphite may be defined as "that allotropic form of carbon having a specific gravity of 2.25 to 2.26."

4. Bailey, W. S., and Stewart, C. A., Note on the occurrence of graphite schist in Tuxedo Park, N. Y.; Econ. Geology, vol. 3, 1908, pp. 535 538. Observations in the New York and New Jersey Highlands west of the Hudson River indicate that graphite occurs (1) as a component of Franklin limestone, (2) in gneisses which may be in part altered sediments but are in places certainly mashed pegmatites, (3) in coarse granite dikes and pegmatites, and (4) in fine-grained quartzitic micaceous schists, especially where these are associated with pegmatites. The last-named occurrences are the most important. Concentrating works at Bloomingdale, Highbridge, and near Brookside have all failed. Describes in detail the occurrence of graphite in schists at Tuxedo Park. The graphite plates are usually in parallel intergrowth with biotite plates. The graphitic schist is believed to be the product of metamorphism of a sediment rich in organic matter. The pegmatite is graphitic only when near the schist or where it carries fragments of this rock.

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16. Cirkel, Fritz, Graphite; its properties, occurrence, refining, and uses: Dept. of Mines, Ottawa, Canada, 1907, 307 pages. The best general treatise on this mineral. Includes detailed descriptions of Canadian graphite deposits, descriptions of foreign occurrences, and bibliography. Illustrated. Reviews theories of T. Sterry Hunt, Weinschenk, Osann, and others. Regards the disseminated deposits of Canada as derived by metamorphism from originally carbonaceous sediments. Reviewed by Frank L. Hess, Econ. Geology, vol. 4, 1909, pp. 661–666, and by H. Mortimer Lamb, Eng. and Min. Jour., vol. 85, 1908, pp. 360–361.

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25. Harnig, A., The application of graphite to the production of crucibles for melting metals: Brass World, vol. 7, 1911, pp. 307–312. (Abstract translation from the German monograph, "Der Graphit," by A. Harnig). An excellent summary of the qualities necessary in graphites used for crucibles. Seven analyses of clays used in graphite crucibles. Describes the methods of crucible manufacture.

26. Hatch, F. H., Report on the mines and mineral resources of Natal, pp. 111–115, 1910. Abstract in Bastin, Edson S., Graphite: Mineral Resources U. S. for 1909, pt. 2, U. S. Geol. Survey, 1911, p. 833. Graphite occurs (1) as small flakes irregularly disseminated through crystalline dolomites and schists; (2) as beds of amorphous graphite formed by contact metamorphism of impure coal seams by intrusive rocks. There has been no important commercial development.

27. Hayes, C. W., and Phalen, W. C., Graphite deposits near Cartersville, Ga.: Bull. U. S. Geol. Survey No. 340, 1907, pp. 463–465. Discusses character, origin, and uses of graphitic talcose slates of Cartersville region. Probably formed by metamorphism of a carbonaceous clay shale.

28. Hess, F. L., Graphite mining near La Colorado, Sonora, Mexico, Eng. Mag., vol. 38, 1909, pp. 36–48. Abstract, in Bastin, Edson S., Mineral Resources U. S. for 1908, pt. 2, U. S. Geol. Survey, 1909, p. 734. The deposits were discovered in 1867, preliminary work begun in 1891, and commercial operations in 1895. The graphite bed now worked reaches 9 to 10 feet in thickness, though locally reduced through squeezing to a thin seam, yet in other places bulging to 24 feet. The wall rock is in most places a sandstone, though locally granite. Limestone also occurs near the mine. The graphite probably represents a coal bed of Upper Triassic age, which was graphitized by the intrusion of granite. The graphite is of the amorphous variety, and it is excavated from extensive underground workings and hauled by 10 to 14 mule teams 20 miles to the railroad at La Colorado. From there it is shipped to the factory of the operating company—the United States Graphite Co., at Saginaw, Mich. Map and sketch plan of vicinity of mines. Seven half-tone illustrations.

29. Hopkins, T. C., Description of graphite properties near Chester Springs, Chester County, Pa.: Mineral Industry, vol. 7, 1898, p. 383.

30. ——— Description of the occurrence of graphite in Berks County, Pa.: Mineral Industry, vol. 8, 1899, p. 350. Quoted in full in Bastin, Edson S., Graphite: Mineral Resources U. S. for 1909, pt. 2, U. S. Geol. Survey, 1911, p. 830.

31. ——— Graphite and garnet: Mines and Minerals, vol. 21, 1901, p. 352. Briefly describes characters and uses of graphite. Mentions the principal localities of graphite production in the world and describes in some detail mines at Chester Springs and Byers, in Chester County, and at Boyertown and Mertztown, in Berks County, Pa.

32. Hyde, F. S., Discussion of assay of graphite by blast and fusion: Mineral Industry, vol. 9, 1900, pp. 380–383.

33. ——— On some characteristics of natural graphite: Mineral Industry, vol. 16, 1907, pp. 574–575.

34. ——— Some characteristics of natural graphite: Eng. and Min. Jour., vol. 85, 1908, pp. 255–256. Describes chemical and physical tests for distinguishing different kinds of natural graphite.

35. Ihne, F. W., Graphite in the South: Manufacturers' Record, vol. 54, 1909, pp. 134–138. Discusses the general character and mode of occurrence of graphite and describes in some detail the deposits in the South Atlantic States. Describes in detail the concentration process of the Southern Graphite Co., of Graphiteville, N. C.

36. ——— Graphite in the United States: Min. Sci., vol. 60, 1909, pp. 297–298, 316–318, 343–346. Describes the occurrence, distribution, and mining of graphite in the United States. Illustrated.

37. ——— General discussion of character of graphite and of graphite mining: Mineral Industry, vol. 17, 1908, pp. 489–497. Particularly full description of the Clay County, Ala., deposits.

38. Imperial Institute, Bulletin of the, Graphite and its uses, vol. 4, 1906, pp. 353–360; vol. 5, 1907, pp. 70–85. Abstract in Canadian Min. Jour., vol. 28, 1907, pp. 171–173. General discussion of the character, occurrence, uses, and concentration of graphite. Summary of its distribution in various parts of the world. Some references.

39. Iron Age, The, Acheson graphite lubricant, May 23, 1907. Discusses the lubricating value of "deflocculated" artificial graphite.

40. Keith, Arthur, Mount Mitchell (N. C.-Tenn.) folio (No. 124), Geol. Atlas U. S., U. S. Geol. Survey, 1905. Describes character and utilization of graphitic schists near Graphiteville, N. C.

41. Kemp, J. F., Graphite in the eastern Adirondacks, N. Y.: Bull. U. S. Geol. Survey No. 225, 1903, pp. 512–514. The graphite deposits are confined to Algonkian rocks and occur (1) in pegmatite veins, (2) as veinlets of graphite, (3) in quartzites, and (4) in crystalline limestones associated with gneissoid strata. Deposit at Chilson Hill near Ticonderoga is briefly described and referred to pegmatite class. Graphitic veinlets at Split Rock on Lake Champlain are described. Description of graphitic quartzites at Hague and a few other localities. These quartzites are regarded as metamorphosed bituminous shales. Milling process at Hague described. Occurrence of graphite in crystalline limestone briefly described.

42. Kemp, J. F., and Newland, D. H., Preliminary report on the geology of Washington, Warren, and parts of Essex and Hamilton Counties, N. Y.: Fifty-first Ann. Rept. N. Y. State Mus., 1897, vol. 2, pp. 537–540. Describes the rocks of Hague as gneisses of several varieties, mostly striking northwest. Crystalline limestone occurs at two points and pre-Cambrian sedimentary schists at several localities. The best exposures of such schists are at the mine at Graphite. The graphite deposit is an impregnation or dissemination of graphite in quartzite. Gives microphotographs of the garnet-sillimanite wall rock. Preliminary concentration at this time was by California stamps and buddles. The further concentration process at the finishing mill at Ticonderoga is secret. Gives a map and structure section of the locality.

43. Law, E. Stanley, Notes on a useful mineral (graphite): The Mineral Collector, vol. 12, pp. 169–173, 180–184. Discusses characters, uses, and production of graphite. Quotes Kemp on occurrence of graphite in New York. Describes in some detail the mode of occurrence and mining and milling methods in Chester County, Pa. Briefly describes the Ceylon occurrences and the methods of artificial production.

44. Lee, Willis T., in Bastin, E. S., Graphite: Mineral Resources U. S. for 1908, pt. 2, U. S. Geol. Survey, 1909, p. 793. Describes the graphite deposit near Raton, in Colfax County, N. Mex. The deposit is nearly horizontal and represents a coal bed graphitized by the intrusion of diabase. A representative sample analyzed 77 per cent graphite. The material has been utilized somewhat in paint manufacture.

45. Meeks, Reginald, Discussion of market for graphite: Mineral Industry, vol. 17, 1908, pp. 497–500.

46. Merrill, George P., The nonmetallic minerals; their occurrence and uses, 1910, pp. 6–14. General discussion of the character, occurrence, origin, and uses of graphite. Short bibliography.

47. Mills, Frank S., The economic geology of northern New York: Eng. and Min. Mag., vol. 85, 1908, p. 397. Describes particularly the property of the Macomb Graphite Co., in St. Lawrence County. The graphite is disseminated as small flakes in quartz schists. A small amount of development work has been done.

48. Mines, Bureau of, Dept. of Agriculture and Commerce, Japan, Mining in Japan, Past and Present. 1909, pp. 133–135. (Two pages in English.) Abstract in Bastin, Edson S., Graphite: Mineral Resources U. S. for 1909, pt. 2, U. S. Geol. Survey, 1911, p. 833. Discusses domestic production and imports and briefly describes the principal occurrences. The bulk of the Japanese consumption is imported from Ceylon, Korea, etc. The domestic occurrences are all in the principal Japanese island of Nippon. Most of the output is crystalline graphite, which occurs disseminated in small flakes in gneiss. Amorphous deposits, probably produced by the contact metamorphic effects of igneous rocks on coal seams, are also worked.

Mineral Industry, 1892 to 1909, vols. 1 to 18. Pub. by Eng. and Min. Jour. Annual statements of the progress of the graphite industry. The special features of most importance as regards graphite are as follows:

49. Mineral Industry, vol. 2, 1893, pp. 335–342. Describes foreign and domestic occurrences and uses, with numerous references to foreign literature.

50. ——— vol. 6, 1897, pp. 387–390. Discusses particularly the use of graphite paint for metallic surfaces.

51. ——— vol. 7, 1898, pp. 382–387. Description, by T. C. Hopkins, of graphite properties near Chester Springs, Chester County, Pa., with quotation from Weinschenk on mode of occurrence in Bavaria and Bohemia.

52. ——— vol. 8, 1899, pp. 348–352. Description, by T. C. Hopkins, of the occurrence of graphite in Berks County, Pa. Quoted in full in Bastin, Edson S., Graphite: Mineral Resources U. S. for 1909, pt. 2, U. S. Geol. Survey, 1911, p. 830. Discussion, by E. G. Acheson, of artificial graphite.

53. ——— vol. 9, 1900, pp. 378–383. Discussion, by F. S. Hyde, of assay of graphite by blast and fusion.

54. ——— vol. 10, 1901, pp. 367–373. Two pages devoted to artificial graphite.

55. ——— vol. 11, 1902, pp. 343–353. Discussion, by W. E. H. Carter, of the graphite industry in Canada during 1902. Two pages on artificial graphite.

56. ——— vol. 12, 1903, pp. 183–187. Devotes 1½ pages to the Ceylon deposits.

57. ——— vol. 14, 1905, pp. 311–312. A short description (one-third of a page) of the graphite deposits near Charlottesville, Va.

58. ——— vol. 16, 1907, pp. 567–575. Description, by F. S. Hyde, of some characteristics of natural graphite, and descriptions by other writers of occurrence of graphite in Alabama, New Jersey, and Wyoming.

59. ——— vol. 17, 1908, pp. 488–500. General discussion, by F. W. Ihne, of graphite and graphite mining. Particularly full description of the Clay County, Ala., deposits. Discussion, by Reginald Mecks, of market for graphite.

60. ——— vol. 18, 1909, pp. 384–390. Devotes 2½ pages to foreign graphite occurrences.

61. Moffit, Fred H., The Nome region: Bull. U. S. Geol. Survey No. 314, 1907, pp. 139–140. Abstract in Bastin, Edson S., Graphite: Mineral Resources U. S. for 1909, pt. 2, U. S. Geol. Survey, 1911, p. 818. Describes briefly (one page) the character and mode of occurrence of graphite on the south side of the Kigluaik Mountains, Seward Peninsula, Alaska.

62. Moissan, Henry, The electric furnace (authorized translation by Victor Lehner), 1904, pp. 50–79. Describes the behavior of various natural terrestrial graphites upon heating or treatment with certain reagents, also graphites obtained from the terrestrial iron of Greenland and from several iron meteorites. Describes the process of formation and the characters of various artificial graphites produced both by simple elevation of temperature and by the solution of carbon in different metals. The experiments appear to indicate that graphite formed at high temperatures is less readily attacked by the usual reagents than that formed at lower temperatures. The swelling exhibited by certain graphites when heated with aqua regia is believed to be due to the sudden evolution of gases. All the artificial graphites produced by simple elevation of temperature were nonswelling; all obtained from fusion with metals exhibited swelling. The temperature of swelling lies between 165° and 175° C.

63. Nason, Frank L., Geological studies of the Archean rocks: Ann. Rept. of State Geologist of New Jersey, 1889, pp. 27–29 and 64–65. Describes the distribution of several belts of graphitic schists in the New Jersey Highlands.

64. Newland, D. H., The mining and quarry industry of New York State: Bull. New York State Mus., Nos. 93, 102 ,112, 120, 132, 142, 1904–1909. Annual statistics of the production of graphite and reports on the progress of the industry. The more important locality descriptions are listed below:

65. Bull. 102, 1905, pp. 73–78. Describes briefly mines at "Graphite," in Warren County, Rock Pond, and Mineville, in Essex County, and Dresden, in Washington County. Devotes one-half page to milling methods.

66. Bull. 120, 1907, pp. 29–31. Describes briefly mines near Conklingville, in Saratoga County, and near Rossie, in St. Lawrence County. Discusses effects of presence of mica and influence of size of graphite flake in concentration.

67. Bull. 142, 1909, pp. 37–38. Describes the graphite property of W. H. Faxon, near "Graphite."

Newland, D. H., Kemp, J. F., and. *See* Kemp and Newland.

68. Nicholas, F. C., A novel graphite washing plant: Min. World, vol. 28, 1908, p. 18. Describes concentrating process at plant of Empire Graphite Co., Saratoga County, N. Y.

69. Ogilvie, Ida H., Geology of the Paradox Lake Quadrangle, N. Y.: Bull. N. Y. State Mus. No. 96, 1904. Describes sillimanite gneiss associated with graphitic rock at "Graphite" (6 lines, p. 495). Describes mode of occurrence of graphite at "Graphite," Warren County, and at Rock Pond, Essex County (pp. 503–505). Cites Weinschenk on origin of graphite (10 lines, p. 504). "The Adirondack graphite is plainly of two kinds—that present as an accessory constituent of the limestone and quartzite, and that occurring in a secondary position along fault lines." The former is regarded as an original carbonaceous constituent of sediments, graphitized by dynamic metamorphism. The latter represents a part of the graphite which was volatilized during the same metamorphism transported somewhat and later sublimed along fracture planes.

70. Paint Manufacturers' Association of the United States, Philadelphia, Pa. Scientific Section, 1908. Preliminary report on steel test fences. Describes methods of testing the protective qualities of graphite and other pigments. Results not reported.

71. Paige, Sidney, Graphite in the Llano-Burnet region, Texas: Bull. U. S. Geol. Survey No. 450, 1911, pp. 77–82. Author's abstract in Mineral Resources U. S. for 1909, pt. 2, 1911, pp. 830–832. Describes the occurrence of disseminated flake graphite in the pre-Cambrian schists of this region. A composite sample from the principal prospect showed 11.45 per cent of graphite. Serious development has not been attempted.

Phalen, W. C., Hayes, C. W., and. *See* Hayes and Phalen.

72. Pratt, J. H., Graphite: Mineral Resources U. S. for 1903, U. S. Geol. Survey, 1904, pp. 1121–1129. Describes processes of making artificial graphite. Quotes Young on assaying graphite ores.

73. ——— Graphite: Mineral Resources U. S. for 1904, U. S. Geol. Survey, 1905, pp. 1157–1167. Good brief summary of occurrence and uses.

74. ——— The Mining Industry of North Carolina: North Carolina Geol. Survey Econ. Papers Nos. 4, 6, 7, 8, 9, 11, 14. Annual statistics of production and record of the progress of the graphite industry. The most important detailed description is in No. 6, 1901, which describes the occurrence of graphite disseminated in gneiss in McDowell, Wake, and Catawba counties, and in pegmatite in Alexander County.

75. Richards, J. W., The electrochemical industries of Niagara Falls: The International Acheson Graphite Co.: Electrochem. Industry, 1902, pp. 52–54. Describes in detail the process of manufacture of artificial graphite. Illustration of furnaces.

76. Sadler, S. S., Determining ash in graphite: Australian Mining Standard, December 11, 1907. Small quantities of magnesia are added to the samples to prevent the residue from fusing to the crucible. The ash can then be readily removed and analyzed.

77. Stutzer, O., Die wichtigsten Lagerstätten der "Nicht-Erze" [The more important occurrences of the nonmetallic minerals], Berlin, 1911. Section on Graphite, pages 1–88. The best and most comprehensive summary of the geology of the more important graphite deposits of the world. Uses, methods of treatment, etc., are only briefly considered.

78. ——— Über Graphitlagerstätten: Zeitschr. prakt. Geologie, vol. 18, 1910, pp. 10–17. Virtually an abstract of 77.

79. Smith, Eugene A., Graphite in Alabama: Mineral Industry, vol. 16, 1907, pp. 567–568. Includes a description (two-thirds page) of the Clay County deposits.

80. Smith, G. O., Graphite in Maine: Bull. U. S. Geol. Survey No. 285, 1906, pp. 480–483. Describes origin, mode of occurrence, and possible utilization of graphite at Madrid, Franklin County, and at Yarmouth, Cumberland County. Regards graphite occurring in pegmatite at Yarmouth as of magmatic origin.

81. ——— Graphite: Mineral Resources U. S. for 1905, U. S. Geol. Survey, 1906, pp. 1265–1269. Describes the occurrence of graphite as an original constituent of certain granitic rocks; discusses the kinds of graphite best suited to the manufacture of crucibles and of lead pencils.

82. ——— Graphite: Mineral Resources U. S. for 1906, U. S. Geol. Survey, 1907, pp. 1139–1143. Summarizes the characters, occurrence, and uses of graphite.

83. Smith, Philip S., Investigations of the mineral deposits of Seward Peninsula: Bull. U. S. Geol. Survey No. 345, 1908, p. 250. Abstract in Bastin, Edson S., Graphite: Mineral Resources U. S. for 1909, pt. 2, U. S. Geol. Survey, 1911, pp. 818–819. Describes briefly (one-half page) the character and mode of occurrence of graphite on the north side of the Kigluaik Mountains, Alaska.

84. ——— Recent developments in southern Seward Peninsula: Bull. U. S. Geol. Survey No. 379, 1909, pp. 300–301. Abstract in Bastin, E. S., Graphite: Mineral Resources U. S. for 1909, pt. 2, U. S. Geol. Survey, 1911, pp. 818–819. Describes briefly (three-fourths page) the character and particularly the method of development of the graphite deposits on the north side of the Kigluaik Mountains, Alaska.

85. Standish, Alfred, The electric furnace, 1908, pp. 142–149. Good summary of processes and principles of the commercial production of artificial graphite and diagrams of electric furnaces used.

Stewart, C. A., Bailey, W. S., and. *See* Bailey and Stewart.

86. Townsend, C. P., The artificial production of graphite: Elec. World and Engineer, vol. 37, 1901, pp. 546–550. An excellent review of the various methods of the artificial production of graphite, and a discussion of the chemical changes involved.

87. Walcott, C. D., Pre-Cambrian fossiliferous formations: Bull. Geol. Soc. Am., vol. 10, 1899, p. 227. Devotes one paragraph to the mine at "Graphite" in Hague, Essex County, N. Y. "The appearance [of this graphitic bed] is that of a fossil coal bed, the alteration having changed the coal to graphite and the sandstone to indurated, garnetiferous, almost quartzitic sandstones." Reproduces photograph of graphitic bed (pl. 22).

88. Walker, John A., The manufacture and use of lead pencils: Graphite Tradesman (published by Joseph Dixon Crucible Co.), August 15, 1906. History and method of lead-pencil manufacture.

89. Watson, Thomas L., Mineral Resources of Virginia, 1907, pp. 188–190. (Published by Jamestown Exposition Commission.) Mentions the localities at which graphite has been found in Virginia. No detailed descriptions.

90. White, David, Some problems of the formation of coal: Econ. Geology, vol. 3, 1908, p. 298. The discovery of hydrocarbon-bearing strata composed largely of such organisms (algæ) in rocks as old as the Ordovician strongly suggests an algal origin for the graphites interbedded in still older metamorphic sediments of the Laurentian or the Algonkian.

91. Winchell, Alexander N., Graphite near Dillon, Mont.: Bull. U. S. Geol. Survey No. 470, 1911, pp. 528–532. See next reference.

92. ——— A theory for the origin of graphite as exemplified in the graphite deposit near Dillon, Mont.: Econ. Geology, vol. 6, 1911, pp. 218–230. This article covers in more detail the same ground as 91. It describes the mode of occurrence of graphite on the property of the Crystal Graphite Co., near Dillon, and discusses various theories of graphite formation. To account for the veinlike deposits the writer suggests that a reversible reaction may have taken place whereby the water vapor of a granitic magma first reacted with carbon in bordering carbonaceous rocks with the resulting formation of oxides of carbon (mainly CO) and hydrogen; that these gases became incorporated in the magma; and that they were finally given off as the magma cooled and penetrated fissures in the rock where, through a reversal of the reaction, graphitic carbon and water were formed.

MAGNESITE.

By Hoyt S. Gale.

PRODUCTION.

The production of magnesite apparently fell off in 1911, probably because of the closing down at Red Mountain, southeast of Livermore, in the northeast corner of Santa Clara County, Cal. All the magnesite produced in this country comes from California. The total production reported was 9,375 tons of crude magnesite, valued at $75,000, estimating the average value of the ore at $8 a ton. This value is somewhat higher than the price fixed for the crude ore in 1910, but is thought to be the present value of this product as mined and laid down at the point of shipment. As a matter of fact, most of the magnesite produced in California is not shipped as mined, but is calcined at the mine, thereby reducing its weight approximately one-half and correspondingly increasing the value of the product as shipped. For the present purpose, however, it is desired to reduce the statistics of production to terms of raw material at the mine, and not to use higher figures, representing more or less manufactured products, where they can be avoided.

Interest in the California magnesite has been somewhat revived, in anticipation, doubtless, of the advantages which should accrue from the opening of the Panama Canal. At least two new deposits of probable importance have been developed within the year, and some others are reported. A brief description of the probably important new deposits accompanies this report.

The principal markets of the eastern United States and the Mississippi Valley are supplied by importation, in spite of the recognized high grade of our own magnesite and of the large undeveloped deposits of this material that are known to exist in California. Imported magnesite is quoted at $10 to $11 per long ton for the raw and $30 to $35 for the calcined and powdered product at New York. It is thus evident that the present transportation rates put the California magnesite at a disadvantage that restricts its use practically to the State.

The imports for the year 1911 amounted to 122,075 short tons of calcined and 12,974 short tons of crude magnesite, not including the refined magnesia salts used for medicinal and other purposes. This is equivalent to about 14½ times the quantity of the home production.

Only three mines reported production in 1911. Much the larger part of the production for 1911 came from the Tule River deposits, in Tulare County, near Porterville. The deposit near Winchester, in Riverside County, was also a producer, and properties on Kings River about 10 miles east of Sanger, in Fresno County, also reported an output. One new mine at Iowa Hill, Placer County, was opened in 1911, and a few hundred tons of magnesite were extracted, but none of this product was shipped or calcined.

The following table shows the quantity and value of the domestic output from 1891 to 1911, inclusive:

Quantity and value of crude magnesite produced in the United States, 1891–1911.

1891	short tons	439	$4, 390
1892	do	1, 004	10, 040
1893	do	704	7, 040
1894	do	1, 440	10, 240
1895	do	2, 220	17, 000
1896	do	1, 500	11, 000
1897	do	1, 143	13, 671
1898	do	1, 263	19, 075
1899	do	1, 280	18, 480
1900	do	2, 252	19, 333
1901	do	3, 500	10, 500
1902	short tons	2, 830	$8, 490
1903	do	3, 744	10, 595
1904	do	2, 850	9, 298
1905	do	3, 933	15, 221
1906	do	7, 805	23, 415
1907	do	7, 561	22, 683
1908	do	6, 587	19, 761
1909	do	9, 465	37, 860
1910	do	12, 443	74, 653
1911	do	9, 375	75, 000

IMPORTS.

The imports of magnesite into the United States from 1908 to 1911, as furnished by the Bureau of Statistics, are given in the following table:

Imports of magnesite into the United States from 1908 to 1911, in pounds.

	1908		1909		1910		1911	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Magnesia:								
Calcined, medical	46,823	$7,451	52,247	$8,697	61,471	$9,519	91,029	$13,694
Carbonate of, medical	62,514	3,475	49,115	3,328	46,926	2,799	50,490	2,867
Sulphate of (Epsom salts)	4,990,875	15,543	6,612,956	28,180	6,748,388	23,565	5,950,861	22,559
Magnesite:								
Calcined, not purified	129,462,109	655,245	208,947,602	939,014	297,652,901	1,380,731	244,149,581	1,109,770
Crude	39,526,865	81,518	19,635,479	46,005	52,002,557	162,069	25,948,797	76,097

DOMESTIC DEPOSITS.

Some of the new developments in magnesite deposits were investigated in the field and brief descriptions of the properties visited are given here. A number of samples, mostly of rock taken from newly opened workings, were collected and analyses of them are included in the following pages.

NEWLY DISCOVERED DEPOSIT AT BISSELL STATION, NEAR MOHAVE, CAL.

During the year 1911 a new deposit of magnesite was developed near Bissell station, on the Santa Fe Railway, 11 miles east of Mohave, Kern County, Cal. It is said to have been located in part by Messrs. B. M. Denison, of Tehachapi, and D. S. Clark, of San Pedro, Cal., and in part by Messrs. C. A. Williams and J. N. Conover, both of Tehachapi, Cal.

The deposit is situated about one-half to three-quarters of a mile northeast of Bissell station. The only developments that had been made up to March 8, 1912, consisted of a series of pits and a few shallow shafts opening the deposit through a stretch of about a quarter of a mile. The accompanying map (fig. 12) was prepared by Leon J. Pepperberg and is here published for the first time.[1]

This deposit is unique in being the only occurrence of magnesite of evidently sedimentary origin yet found in this country. Some deposits in Quebec are described as probably of sedimentary origin, but hitherto all the California magnesite has been described as associated with and evidently derived from the altered basic intrusive igneous rocks of a type carrying a large percentage of magnesia.

The magnesite at Bissell occurs in definitely bedded form, interstratified with clays and clay shales, and evidently forming a part of the same series that shows massive ledges of limestone and cherty layers in outcrop near by. The clay beds are prevailingly dull greenish, but in places consist of a very dark carbonaceous material. The locality being in the low rounded hills that characterize this part of the Mohave Desert, the strata in general do not outcrop well and consequently are not readily traced. The limestone and cherty ledges are visible, however, and recent prospecting has revealed the softer magnesite-bearing beds to some extent. The outcrops prospected occur on the south slope of a low ridge.

The dip of the beds is steep and in most places is inclined to the south, but in others is practically vertical. The beds are very irregular in trend and, in fact, are so much contorted locally that it was not possible to determine from the surface indications the structural relations between strata exposed in closely adjacent prospect pits.

The following sections—partly measured, partly estimated—serve to indicate the character and thickness of the beds of magnesite and associated materials. The exposures given in these sections afford what is regarded as sufficient evidence of the original bedded character of the deposits. The extreme irregularity of the beds in some of the pits is thought to be due chiefly to structural distortion, but it is not known how constant the magnesite strata may prove to be.

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[1] By permission of the consulting geologist of the Southern Pacific Co.

Section at 14-foot shaft near west end of Bissell prospects.

[Some magnesite at top not included.]

	Ft.	in.
Cherty layer		6
Clay, carbonaceous, lenticular, about		4
Magnesite, white, about		5
Clay, gray, about		3
Magnesite, white, about		6
Clay, dark gray		4
Magnesite, white		4
Clay, white (magnesite?)		8
Magnesite, clear white, massive	1	6
Clay, brown		4
Magnesite, white, about	1	
Clay, greenish, about		3
Magnesite, compact white		10
Clay (considerable body).		
Total measured	7	3

A sample marked E for analysis, taken at this place, consisted of selected pieces of the hardest and whitest magnesite-like rock from the dump, and was intended to represent the best of this ore near the surface.

The beds exposed in this section are largely lenticular in their thicker parts. They also show slip planes and are not uniformly as distinctly bedded as at other points in these deposits. The strike at this place was recorded as N. 15° W., with a dip of 60° E., which is almost directly transverse to the trend of nearly all the other exposures throughout the prospected ground.

About 300 feet west-northwest of the 14-foot shaft referred to in the section quoted above is a prospect hole about 2 feet deep showing dark-brown carbonaceous beds interstratified with pure white magnesite, one bed of magnesite being at least 15 inches thick. The strike here is N. 60° W. and the dip is 45° S.

About 450 feet a little north of east from the same shaft is a hole 12 feet deep showing two rather thin beds of apparently good solid white magnesite. About 700 feet northeast of this shaft is a trench showing several 6 to 8 inch beds of what is supposed to be good white magnesite, interstratified with greenish clay shale.

About the same distance from the shaft and 150 to 200 feet southeast of the locality last mentioned is a prospect trench showing the following section:

Section in prospect trench near Bissell station.

	Ft.	in.
Magnesite		7
Clay, brownish		1
Magnesite	3	
	3	8

An average sample (marked A) was taken at this place and was cut across the entire face represented in the foregoing section except the 1-inch bed of brownish clay, which readily splits from the magnesite beds. The lower part of the 3-foot magnesite bed contains some thin clayey streaks, 3 or 4 inches to 8 inches apart, which were included in sampling. This was a shallow pit that had been dug very recently and made a very good showing of white hard magnesite in regularly bedded form. The strike here is N. 80° W. and the dip 25° S.

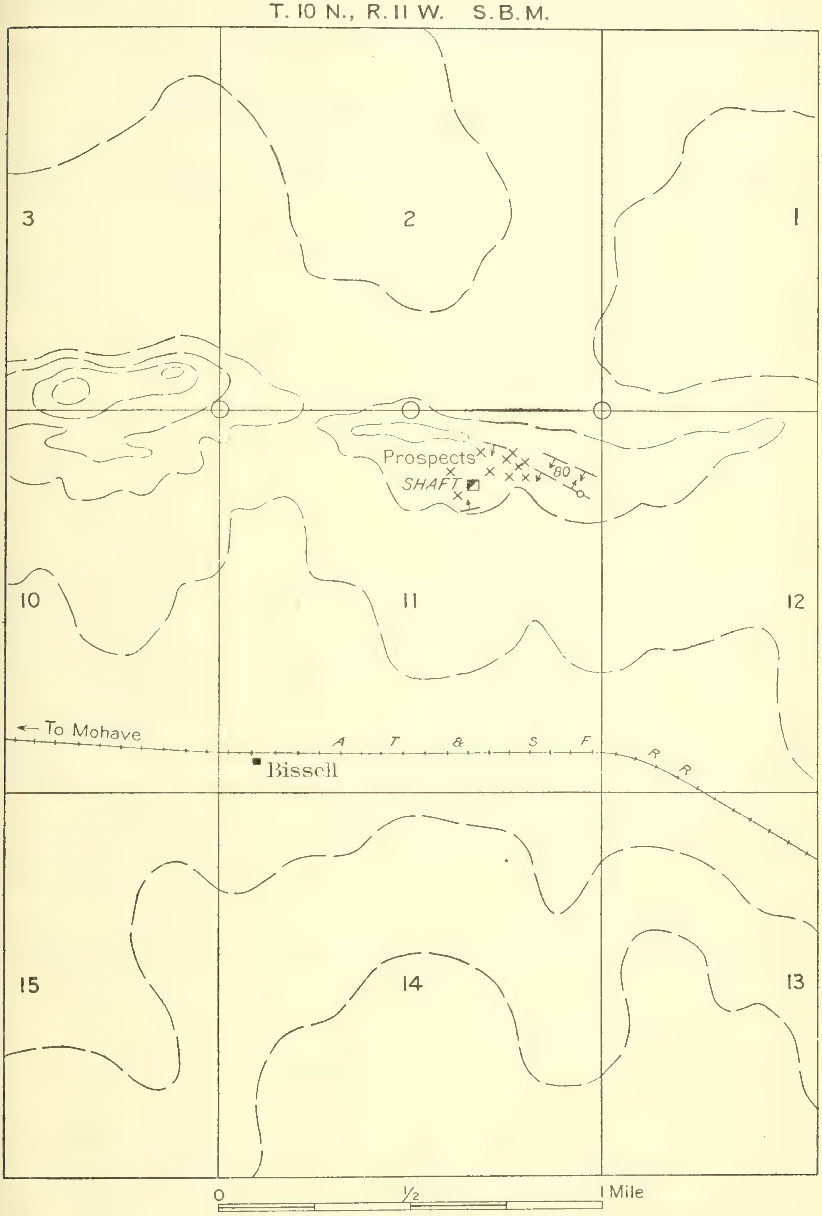
T. 10 N., R. 11 W. S.B.M.
3
2
1
Prospects
SHAFT
80
10
11
12
← To Mohave
A T & S F R R
Bissell
15
14
13
0
½
1 Mile

FIGURE 12.—Reconnaissance map of magnesite deposits at Bissell station, near Mohave, Kern County, Cal. By Leon J. Pepperberg.

Sample marked B is a selected piece of the best-looking magnesite from the same place as that marked A. This has not been analyzed.

Sample marked C represents a 6-inch layer of white clay overlying the section from which sample A was taken and was saved to be tested for magnesia. Analysis shows it to be of essentially the same composition as the underlying magnesite beds.

Sample D consists of other pieces like that marked B, and was collected for analysis.

The results of the analyses of these samples are given below.

Another prospect 150 to 200 feet south-southeast of that from which samples A–D were taken (this being about 750 feet a little north of east from the 14-foot shaft first described) shows the following section:

Section at prospect near Bissell station, Cal.

	Ft.	in.
Magnesite		4
Clay, thin streak.		
Magnesite		2
Clay, thin streak.		
Magnesite		2
Clay (with thin streak of magnesite)		6
Magnesite		8
Clay, greenish	1	3
Magnesite		2
Clay, greenish	1	
	4	3

The strike of the beds at this place is N. 85° W., and dip 75° S.

North of these prospects, within a fourth of a mile, is the crest of the low rounded east-west ridge, and here are to be found occasional outcrops of the harder strata that lie on that side of the magnesite series. These ledges consist of creamy white limestone and sandy shale layers, the shale showing chiefly as float on the surface. Some of the limestone is exceedingly cherty, the chert occurring as compact black flint nodules, in some places strewed thickly over the surface. Similar chert is to be found south of the magnesite beds, so that it doubtless both underlies and overlies the magnesite.

Another prospect on white material said to be magnesite could be seen a half mile or more east of the property examined, but this prospect was not visited.

The following are the results of analyses of the samples described with the foregoing sections. The analyses were made in the laboratory of the Geological Survey at Washington by J. G. Fairchild.

Analyses of samples of magnesite from Bissell, Cal.

	A	C	D	E
SiO_2	9.64	8.51	6.03	4.75
$Al_2O_3Fe_2O_3$	2.46	2.94	1.40	0.76
CaO	4.25	3.36	1.56	Trace.
MgO	37.19	38.32	42.78	44.20
CO_2	40.70	40.12	45.78	47.32
Loss and undetermined	5.76	6.75	2.45	2.97
	100.00	100.00	100.00	100.00

Theoretically pure magnesite is composed of 47.6 per cent magnesia plus 52.4 per cent carbon dioxide. In the foregoing analyses it may be seen that, except in A, carbon dioxide is not present in sufficient quantity to satisfy the magnesia alone if it were all combined as normal magnesium carbonate, even neglecting the fact that the lime is as likely to be in the form of carbonate as the magnesia, and might be combined with some of the carbon dioxide. It is probable that part of the silica in this sedimentary material is free and that some of it is combined with lime and magnesia to form silicates. F. W. Clarke suggests the possible presence of basic carbonates, such as hydromagnesite ($3MgCO_3Mg(OH)_2+3H_2O$), which would tend to compensate the proportions, by the relatively smaller amount of carbon dioxide required in its composition.

The magnesite can be obtained in very clean white masses, as it readily separates from the inclosing clay. It is pure white, very fine grained, and compact, breaking with a chinalike conchoidal fracture, such as is characteristic of natural magnesite. On exposure to the air, however, the material from this deposit shows a tendency to break down, not before noted at other deposits. A rain a short time before the date of visit had wet the magnesite on the prospect dumps and the lumps were said to have cracked and broken down like lime starting to slack. It was observed that only the fresher-dug material afforded the more solid specimens. Disintegration by weathering may give to the surface of these deposits a somewhat coarser and more earthy texture than the porcelainlike fracture characteristic of magnesite, but the rock has nevertheless a marked similarity to the typical magnesite. It would perhaps be surprising if a sedimentary deposit of this sort should be found to carry as low a percentage of lime as is contained in many of the other California magnesites.

It has been stated upon authority that all the California magnesite deposits, so far as known, occur as veins in connection with serpentinized magnesian rocks, usually referred to as serpentines. No evidence of any association with serpentines was observed at the Bissell deposits which, it may be noted, had not been discovered when the above statement was published.

A suggestion as to the possible origin of these deposits may be found in considering the character of the salines commonly associated with the lake-bed deposits of the desert basins. Magnesium is commonly absent from the soluble salts of the desert lake salines, although magnesium salts are common constituents of spring waters in Tertiary and Mesozoic rocks in other parts of the Western States. Many of the lake waters now in the Great Basin area are rich in sodium carbonate, which would of course precipitate as magnesium carbonate any soluble magnesium salt introduced. Possibly, therefore, spring or other waters bearing magnesia salts, generally the sulphate, entered a lake basin containing sodium carbonate in solution, with the result that magnesium carbonate was precipitated, forming bedded deposits. The relatively greater solubility of magnesium sulphate as compared with calcium sulphate would perhaps explain the predominence of magnesia over lime in the resulting precipitate. It is also suggested that if this magnesite were thus precipitated it would likely be, in part at least, laid down as hydromagnesite, and that it would have been deposited most thickly near the source of supply and thus the beds would necessarily be lenticular.

DEVELOPMENT OF A DEPOSIT OF MAGNESITE IN SOUTHERN SAN BENITO COUNTY, CAL.

Some prospecting has been done within the year on a large outcrop of magnesite in southern San Benito County, Cal., on property which has been designated as the Sampson Magnesite Lode claims. In February, 1912, when this deposit was visited by the author, it was stated that a group of 14 claims had been located. The location of the claims is given as sec. 35, T. 17 S., R. 11 E., M. D. M. They are situated a little more than a mile west of Sampson Peak, and about 2½ miles west of the New Idria quicksilver mine, in the rugged slopes of the Diablo Range, at an altitude of more than 3,000 feet. The outcrops are found near the head of the canyon of Larious Creek, a tributary of Vallecitos Creek, just above the junction of that stream with Silver Creek. Silver Creek flows northward from the New Idria mine through a picturesque and rugged canyon and, joining Panoche Creek, turns northeastward through a broader canyon for a mile or two, then distributes itself on the plains of the San Joaquin Valley. The deposit is 35 to 40 miles from the nearest railroad point, Mendota, in the San Joaquin Valley, which may be reached by wagon road following the streams named above. On account of the brief time allotted for the examination of this property only the most general description of the deposit can be given. The geology of this general vicinity is described in some detail in a recent paper on the oil prospects of the region.[1] The large area of serpentine exposed in the crest of the Diablo Range is described as a batholithic intrusive exposed along the crest of a major anticlinal axis of the adjacent sedimentary rocks. An excellent section of the overlying or intruded sediments is to be observed in the canyon of Larious Creek between the serpentine area and the valley of Vallecitos Creek.

The magnesite occurs on the summit of a high spur lying between two forks of Larious Creek. The outcrop of the magnesite body is from 2 to 3 acres in extent. The main crest of the ridge at this place shows a trend about N. 70° E. and is composed entirely of very large and very massive crags of apparently pure white magnesite. If this is the outcrop of a steeply dipping vein of this material, it probably represents a large body of magnesite 50 feet more or less in width. Possibly the other large blocks that lie on the surface of the 2 or 3 acres thereabouts are broken down from this outcrop, or they may be derived from other veins. It is also possible that the whole mass exposed lies in blanket or nearly horizontal vein form and will be found to have little depth. It is considered more likely that this is a steeply dipping vein, but this can only be proved by further development. A tunnel had failed to cut the magnesite at depth, giving ground for the idea that part of the magnesite shown on the surface of the ridge above had slid from the outcrop a little higher on the ridge.

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[1] Anderson, Robert, and Pack, R. W., Geology and oil prospects of the east flank of the Diablo Range, California, north of Coalinga: Bull. U. S. Geol. Survey (in preparation).

An extension of this deposit or another similar vein outcrops considerably lower on the slope of the ridge about N. 70° W. from the main deposit, but this has not been prospected.

In the forks of Larious Creek, below the high massive deposit of magnesite, and about half a mile a little northwest of it, is a great mass of deeply decayed serpentine filled with rounded grains or small masses of white powdery magnesite and a reticulated mass of seams or veins of magnesite, so that the whole mass, which forms large wash banks, has a whitish appearance. The proportion of magnesite to country rock in this mass may be considerable, perhaps 5 per cent or more in places, and it might possibly be utilized in some way in its present state. The round nodular form of the magnesite dotted throughout this weather-decayed mass of serpentine suggests the formation of the magnesite in place by a decomposition of the country rock. The identification of the white powdery material as magnesite is uncertain, as no chemical test has been made of this part of the deposit. The serpentine is a ground mass of schistose or foliated dark-greenish and slickensided fragments.

The surface of the district is deeply dissected by the stream canyons. The creek waters are clear and sparkling and have a marked alkaline taste, even when cold. They were flowing in fair volume in February.

An outcrop sample of the magnesite has been analyzed by J. G. Fairchild in the laboratory of the United States Geological Survey, at Washington, with the following result:

Analysis of outcrop sample from magnesite deposit near Idria, San Benito County, Cal.

SiO_2	0.14
$Al_2O_3.Fe_2O_3$	.48
CaO	.59
MgO	47.07
CO_2	50.66
Loss and undetermined	1.06
	100.00

This analysis indicates that the magnesite is of rather unusual purity.

The principal disadvantage that commercial exploitation of this property will have to contend with—assuming the quality of the magnesite to be satisfactory throughout, as indicated by the single analysis quoted—is long distance from transportation facilities. Shipments of mercury from the New Idria mine have until recently gone northward down the valley of San Benito River to Hollister or Tres Pinos, which is a wagon haul of 60 miles or more, and provisions for the mine have come in over the same route. Recently the road through the canyon of Silver Creek to Mendota, in the San Joaquin Valley, has been repaired and may provide a shorter haul. It has been suggested that a railroad route may be projected down this valley.

MAGNESITE IN THE CANTUA REGION, CALIFORNIA.

Magnesite has been observed in the eastern foothills of the Diablo Range in the vicinity of the deposits described above. Whether of economic importance or not, this occurrence furnishes interesting data as to the age and possibly indications as to the former distribution of such deposits. The following memorandum is quoted from manuscript by Anderson and Pack:

> In the middle of the exposed Tertiary series skirting the western border of the San Joaquin Valley, about 15 miles east of New Idria, there is a formation ranging in thickness from less than 50 feet to several hundred feet, composed almost entirely of comminuted serpentine and of serpentine bowlders. It is of lower Miocene age and probably represents a near-shore marine deposit. It goes by the name of the "Big Blue." The beds composing this formation extend for a distance of about 20 miles along the foothills and lie directly east of the large mass of serpentine that is intrusive into the Franciscan rocks in the core of the range south of New Idria. The débris forming these beds has evidently been derived from that mass and has been carried by streams at least 10 miles.
>
> At several places the "Big Blue" contains fragments a few inches in diameter of pure hard magnesite. They were noticed especially just south of Cantua Creek, and between there and Salt Creek, in the patches of these beds that have been left as remnants overlying the older formations. The fragments are in places scattered over the surface at intervals of a few hundred feet. They are without question of the nature of bowlders derived by erosion from the serpentine area. They are not believed to represent an accumulation in any commercial quantity, but are mentioned only because they point to the presence of magnesite in the serpentine area on the west and prove that some at least of the magnesite veins originated in or prior to the early Miocene.

MAGNESITE DEPOSITS NEAR WINCHESTER, RIVERSIDE COUNTY, CAL.

Production from the deposit of magnesite now being worked near Winchester, Riverside County, Cal., has continued since the latter part of 1908 with a uniform and normal growth. This deposit has been described,[1] and only a few additional notes chiefly concerning its present status will be given here. The views accompanying the account by Mr. Hess illustrate well the character of the veins that are being worked in Riverside County.

The Winchester deposit is owned and operated by the California Magnesite Co. and the entire product of the mine at Winchester is manufactured into cement or is sintered for furnace use at the company's plant in Los Angeles. This appears to be the only output of domestic magnesite that is utilized largely for plastic purposes. A large part of the company's product as shipped consists of finely ground plaster, which is marketed in barrels and is quoted at a much higher price than the raw or roughly calcined product from other mines.

The magnesite mined at Winchester is derived from deeply decomposed serpentine rock, which is found at the crest of one of the steep peaks that form the divide between the valley in which the town of Winchester is situated and Diamond Valley, on the south. The mine is about 2 miles in an air course from the nearest point on the railroad and is 4 miles by good road from the shipping point at Winchester. The broad, flat valley north of the magnesite property is largely under cultivation and the steep little hills at its margin rise abruptly 600 to 700 feet. The open cut of the magnesite mine is about 500 feet above the level of the plain at the valley margin.

The accompanying map (fig. 13) is a topographic and geologic sketch plat of the property including the magnesite mine, reaching from the margin of the valley plain to the crest of the dividing ridge. The property all lies within the NW. ¼ sec. 31, T. 5 S., R. 1 W.

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[1] Hess, F. L., Magnesite deposits of California: Bull. U. S. Geol. Survey No. 355, 1908, pp. 38–39.

The area is somewhat complex geologically. It consists essentially of dark-banded micaceous gneisses and schists, in which the general trend of foliation extends from northwest to southeast and dips steeply to the northeast. The gneiss suggests sedimentary origin, some of the more quartzitic layers resembling conglomeratic material much distorted by shearing. Probably intrusive into the micaceous gneiss is a belt ranging from 200 to perhaps 400 yards wide, extending in a northwest - southeast course from near the northwest corner of the section. Both micaceous gneiss and serpentine are cut by pegmatite dikes, but it appears that some of the larger white pegmatitic feldspar dikes terminate within the serpentine. There are exposures of coarsely crystallized basic rock, which may be the original intrusive, now largely altered to serpentine. A very fresh specimen of this rock, when examined in thin section under the microscope, proves to be a peridotite composed essentially of olivine and enstatite. Crystals of black tourmaline are numerous in some of the pegmatitic dikes.

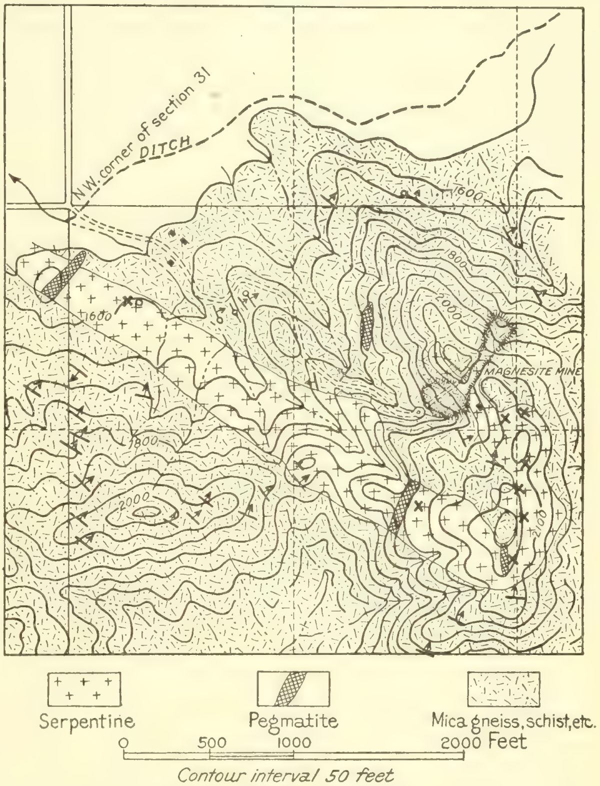

FIGURE 13.—Sketch topographic and geologic map of the magnesite deposit at Winchester, Riverside County, Cal.

F. C. Calkins has examined a specimen of the freshest material from the gulch just below the mine. He reports:

> The chief minerals are enstatite (pale) and olivine (dark). Other original minerals revealed by the microscope in small quantity are iron ore, probably chromite, colorless amphibole, probably tremolite, and diallage, forming a few thin laminæ intergrown with enstatite. A good deal of talc and some carbonate and pale chlorite are present. They seem to have been formed for the most part by the alteration of enstatite, although small particles are scattered through the olivine. The olivine, however, is remarkably fresh; far more so than the enstatite. The cleavage cracks of the olivine contain opaque dust, probably magnetite, and perhaps a very little serpentine, but serpentinization has no more than barely begun.

There are many pits exposing networks of thin veins of magnesite in serpentinous rock decomposed in place. The principal deposit of this sort is that shown in a large open cut crossing the summit of the ridge at its north end and making a prominent landmark visible for miles through the valley on the north. This cut is about 85 yards long and some 25 yards wide at its widest place and is intrenched to a depth of 60 to 75 feet in the crest of the ridge. Dumps have been thrown out at both ends, and from this cut all the shipped ore has been taken out. The cut shows a network of magnesite veins throughout, these being fully as numerous and of as great individual thickness at the present bottom of the pit as they were near the top, or possibly the size and thickness of the veins is even improving with depth. Shear planes within this mass are bounded by banded alteration zones of talc, chlorite, and doubtless other secondary magnesian minerals.

A sample of the magnesite at this place collected by the author was made up of 30 separate portions collected at various parts of this cut, and is believed to be representative of the material as mined. The following analysis of this sample was made by J. G. Fairchild in the laboratory of the Geological Survey, at Washington:

Analysis of average sample collected from magnesite mine at Winchester, Cal.

SiO_2	6.17
Al_2O_3–Fe_2O_3	0.80
CaO	Trace.
MgO	43.80
CO_2	45.02
Loss and undetermined	4.14
	100.00

The following average taken from a mill run shows the composition of the product ground for plastic use, as it is barreled for shipment. The analysis is by E. Miall Skeats, chemist for the company:

Analyses of ground magnesite.

Insoluble	14.00
Iron and alumina	.80
Calcium oxide	.61
Magnesium oxide	84.59
	100.00

The magnesite veins possibly constitute one-tenth of the mass of the decomposed rock as available and recoverable ore, although the actual proportion of magnesite in the finer form may be considerably higher. Thus 8 to 10 or more wheelbarrow loads of waste go over the dump for 1 load of ore saved. There is much fine magnesite in the dump, and it has been suggested by the owners that this might be utilized directly in the manufacture of brick. Some experiments have been made with this end in view.

MAGNESITE DEPOSIT NEAR DEATH VALLEY JUNCTION, INYO COUNTY, CAL.

A deposit of magnesite has been reported in the Amargosa Desert near the California-Nevada State line, on the southern margin of Ash Meadows. It is said to have been first located several years ago, and recently this deposit has been further prospected by Mr. W. P. Bartlett, of Porterville, Cal., who says of it, "The deposit near Death Valley Junction, though resembling magnesite, is only a low-grade dolomite—nearly all lime." At present this is the only information at hand, and it is inferred that the deposit is not of much commercial value.

ABANDONMENT OF THE HARKER MAGNESITE DEPOSITS, NEAR PORTERVILLE, CAL.

The magnesite deposits 4 miles northeast of Porterville, which have been mined continuously since 1901, were abandoned in 1909. Since 1902 these deposits have been operated by the Willamette Pulp & Paper Co. They doubtless still contain much workable and valuable magnesite, but the upper parts of the larger vein have been almost completely worked out. Any further development at this place would doubtless have to be made through new entries opening the deposit on lower levels in the vertical vein. There is a considerable quantity of magnesite remaining in the flat-lying vein on this property, but this vein is difficult to work without timbering, which will make mining in this deposit more expensive than the methods formerly employed. A good description of the Harker deposits with a map and illustrations is contained in a former report of the Geological Survey.[1] The entire equipment, including the furnace, has now been removed from the property.

DEVELOPMENT OF A DEPOSIT ON SOUTH FORK OF TULE RIVER NEAR PORTERVILLE, CAL.

A hitherto undeveloped deposit on South Fork of Tule River, 9 or 10 miles east of Porterville, was opened in 1907 by the Tulare Mining Co., of which W. P. Bartlett is superintendent.

The Tule River deposits were quite fully described as outcrops by Hess[2] before any development or even prospecting had been done on them. To this description of the outcrops there is little to be added, and the following paragraphs concern principally the recent developments for the commercial production of the magnesite.

The magnesite veins are situated in a high hill on the southwest side of South Fork of Tule River, on the north face of the hill in secs. 30 and 31, T. 21 S., R. 29 E.

The Porterville Northeastern Railroad has now been completed along the main valley of Tule River, and at the time when the property was visited preparations were actively being made for building a spur about 2 miles long direct to the magnesite deposits. It was expected that this spur would be completed within a short time.

Recent mining developments on the South Fork of Tule River deposits consist of a 1,400-foot tunnel through the point of a ridge, not far above water level, some other short tunnels, and many small and large open cuts and pits, by which the numerous other outcrops on the property have been prospected. The 1,400-foot tunnel follows an exceedingly irregular vein, which often reaches apparently large dimensions and again is lost altogether. There are crosscuts, which appear to develop large bodies of ore in certain parts, and in places these bodies are mixed with country rock or foreign matter that probably reduce the quality of the ore. Therefore, at the present stage of development it is somewhat difficult to estimate the reserve on this property, which is believed to be rather large. No samples of the ore or calcined product were obtained for analysis owing to lack of time when the examination was made. No raw rock is shipped, all the product being calcined in stack furnaces at the mine.

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[1] Hess, F. L., Magnesite deposits of California: Bull. U. S. Geol. Survey No. 355, 1908, pp. 40–46.

[2] Idem, pp. 46–48.

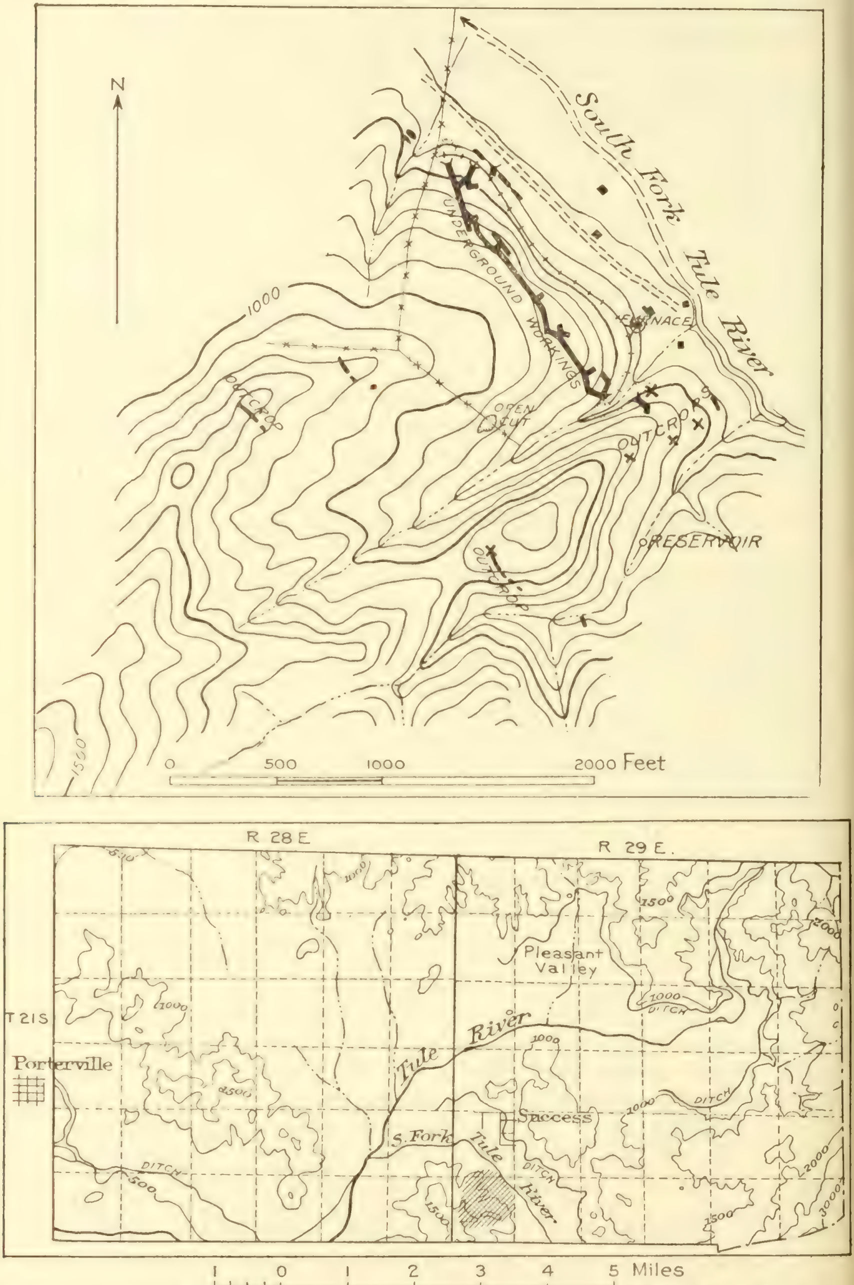
N
South Fork Tule River
UNDERGROUND WORKINGS
FURNACE
1000
OUTCROP
OPEN CUT
OUTCROPS
RESERVOIR
OUTCROP
1500
0 500 1000 2000 Feet
R 28 E
R 29 E.
500
1000
1500
2000
T 21 S
Porterville
Pleasant Valley
DITCH
Tule River
S. Fork Tule River
Success
3000
1 0 1 2 3 4 5 Miles

FIGURE 14.—Sketch topographic map of the magnesite deposits on South Tule River, east of Porterville, Cal., and index map showing location of the deposits.

The accompanying plat (fig. 14) is the result of a hurried sketch traverse of the property, made on February 25, 1912, and although it is not an accurate instrumental survey and is not complete, it will serve to indicate the character and relation of both the developments and the more prominent outcrops.

Much of the information here given concerning production, development, etc., of the deposit near Porterville was obtained through the courtesy and assistance of Mr. W. P. Bartlett, superintendent of the Tulare Mining Co., at Porterville.

USES OF MAGNESITE.

The uses to which magnesite are put have been very thoroughly reviewed in Bulletin 355, previously referred to. They are stated below in the order they are given:

For the manufacture of carbon dioxide.
Changed to the sulphite, for the digestion and whitening of wood-pulp paper.
For refractory brick, shapes, crucibles, and furnace hearths.
For medicinal and toilet purposes.
As pipe covering (mixed with asbestos).
As an absorbent in the manufacture of dynamite.
To prevent scale in boilers in which sulphurous waters are used.
For making oxychloride cement.
As an adulterant in paint.

Magnesite is also recommended for use as a waterproof paint for coating wood or fabric, and for the manufacture of artificial marble and fine tiles, and as a binder for briquetting coals.

At the present time it appears that the use of magnesia for the manufacture of carbon dioxide on the Pacific coast has been given up, as, all things considered, lime is found to be cheaper. The greater part of the California magnesite is still used in the manufacture of paper. All the Porterville product and that from the other deposits, except the one in Riverside County, is used by the Willamette Pulp & Paper Co. and other paper concerns. Of the product from the Winchester deposit, the manufacturer estimates that 90 per cent goes for plastic purposes and 10 per cent for furnace hearths.

Data concerning the use of imported magnesite in the Eastern States are not at hand. It is believed that the greater part of this material goes into the manufacture of refractory brick and furnace linings.

MICA.

By DOUGLAS B. STERRETT.

INTRODUCTION.

The most prominent feature of the minerals of the mica group is their perfect cleavage into tough, flexible, and elastic sheets. The ready cleavage combined with transparency and nonconductivity of electricity render mica valuable in the industrial world. The commercial demand has practically been supplied by two varieties, muscovite and phlogopite, but a small quantity of biotite has been used. Only muscovite and phlogopite have been found in masses of sufficient size and abundance to meet the demands of the trade.

Muscovite, called "white mica," is a silicate of aluminum and potassium containing water; phlogopite, called "amber mica," is a silicate of magnesium, aluminum, and potassium; biotite is a silicate of magnesium, iron, aluminum, and potassium. Phlogopite and biotite may be placed at opposite ends of a chemical series and may grade into each other by variations in the percentage of iron present. In thin sheets muscovite is nearly colorless, phlogopite generally yellow or brownish, and biotite dark brown to black. In sheets of one-sixteenth of an inch or more in thickness muscovite may be colorless, white, gray, yellow inclining to amber, red, brown, or green; phlogopite may be yellow, brown, or black, and sometimes coppery; and biotite is black. Muscovite of a reddish color is often called "rum" and "ruby" mica. The luster of muscovite is brilliant and glimmering on fresh surfaces, and that of phlogopite is less brilliant and more silvery or pearly.

Among the countries contributing to the world's production of mica are India, the United States, Canada, Brazil, Ceylon, German Southwest Africa, and Union of South Africa. Some of these countries produce both muscovite and phlogopite mica and others but one variety. Muscovite, with a small quantity of biotite obtained as a by-product, is the only mica mined in the United States, no valuable deposits of phlogopite having been found

OCCURRENCE.

Mica deposits of value have been found in more than 20 States of the United States. Large productions have been reported from North Carolina, South Dakota, New Hampshire, New Mexico, Idaho, Virginia, Colorado, South Carolina, Georgia, and Alabama. Other States in which mica deposits have been found are Maine, Vermont, Massachusetts, Connecticut, New York, Pennsylvania, Maryland, Wyoming, Texas, Arizona, Utah, Nevada, and California.

The mode of occurrence of muscovite of commercial value in the different localities is similar. In all of them pegmatite is the rock with which the mica is associated. The essential constituents of pegmatite are feldspar and quartz, with which mica may occur as an accessory mineral of more or less prominence. The feldspars are commonly orthoclase or microcline, though a plagioclase, albite or oligoclase, is present in some pegmatites, and locally plagioclase is the predominant feldspar. Pegmatite is therefore allied to granite in composition, but is distinguished from granite by having a coarser texture and greater variations in both texture and composition. In size of grain it ranges from that having the texture of coarse granite to bodies in which the individual minerals occur in crystals or masses several feet across. The mineral masses may be very irregular in shape or arranged in sheets parallel with the walls of the pegmatite. The proportions of the constituent minerals are variable. In some pegmatites the quantity of feldspar present is several times greater than that of the quartz and other minerals; in others quartz is the principal constituent and may compose more than four-fifths of the mass. In a few occurrences over half of the pegmatite is composed of mica.

The shape of pegmatite masses is variable. Some are persistent in length and form dikelike or veinlike sheets that can be traced for several hundred yards. Others are lenticular and occur either in long, slender bodies or in short, thick deposits. Some pegmatite bodies are conformable with the schistosity of the inclosing gneiss or schist either through a part or the whole of their extent; others cut across the bedding of the country rocks. Pegmatites range in thickness from less than an inch to many yards. The least thickness of pegmatite which can be profitably worked for mica might be arbitrarily placed at 1 to 2 feet for rich and persistent veins. Mica-bearing pegmatites in the United States have been found in areas of metamorphic crystalline rocks of pre-Cambrian age. These rocks are gneisses and schists in which the characteristic minerals may be muscovite and biotite mica, garnet, cyanite, staurolite, and hornblende. Some of the rocks are metamorphosed igneous masses, as granite, diorite, and ancient volcanic formations. The rocks with which the pegmatites are associated have been much folded, faulted, mashed, and recrystallized in most areas exposed, and some have been intruded by later granite and other igneous rocks.

NOTES ON MICA LOCALITIES.

North Carolina.—Mr. J. H. Edge, of Celo, N. C., reports having found two large crystals of mica during the year. One of these was 33 inches long, 29 inches wide, and 32½ inches thick, and the other was 33½ inches long, 29½ inches wide, and 17½ inches thick. These crystals were irregularly shaped. The first one mentioned weighed about 800 pounds and brought $125; the second weighed about 700 pounds and brought $100. There was much waste in trimming these blocks of mica to rough sheets, the form in which they were sold.

Messrs. M. Loucks and A. W. Bitner, of the Appalachian Products Co., report the reopening of the old Silley mica mine, 1½ miles from Burnsville, Yancey County, N. C. New shafts and tunnels have located promising bodies of mica and feldspar with kaolin. A 30-horsepower boiler, a 15-horsepower hoisting engine, and a steam pulsometer pump have been installed for operating the mines. A new railroad to Burnsville passes within 450 yards of the mine.

Actual mining of feldspar in North Carolina, with shipments to manufacturers of chinaware, was begun by the Carolina Mineral Co., of Penland, N. C. Mica was obtained during the course of mining and placed on the market.

Texas.—Mica deposits have been developed in El Paso County, Tex., by the Texas Mica Co., of Pecos, Tex. A considerable production is reported, but it had not been sold at the end of 1911. It is expected that much of this mica will be used by the company in the preparation of special products in which it is interested.

Wyoming.—A deposit of mica is being tested in the Medicine Bow Range, Wyo., by L. Learn, of San Diego, Cal. The prospect is about 12 miles west of Fox Park, in Albany County, within the limits of the Medicine Bow National Forest. The elevation at the prospect is about 8,000 feet above sea level. A pit about 10 feet deep was sunk on a well-defined ledge. A small sample of the mica furnished by Mr. Learn was of fair quality.

A photograph has been published by G. H. Lewis,[1] showing a quantity of mica piled around a prospect in Albany County, Wyo. This mica was obtained from a 20-foot shaft in a vein 9 to 20 feet thick. No statement as to the name or location of the prospect accompanies the photograph.

USES.

Mica has a wide commercial application, both in the form of sheet mica and of ground mica. The most extensive use of sheet mica is in the manufacture of electrical apparatus, but a considerable quantity is still used in the glazing trade for stoves, for gas-lamp chimneys, for lamp shades, etc. The demand for mica for glazing is small and only the best quality and the larger sheets are thus used. Both large and small sheet mica is used in the electrical industry. "Micanite," or built-up mica board, for the manufacture of which small-sheet mica can be used, is substituted for large-sheet mica in much electrical work. Mica serves as a perfect insulator in various parts of dynamos, motors, induction apparatus, switchboards, lamp sockets, and nearly every variety of electrical appliance.

The domestic or muscovite mica is satisfactory for all insulation except for commutators of direct-current motors and dynamos built up of bars of copper and strips of mica. For this purpose no mica is as satisfactory as the phlogopite or "amber mica." This mica is of about the same hardness as the copper of the commutator segments and therefore wears down evenly without causing the machine to spark.

Statements have been made in the literature on mica that mica which contains inclusions of black "specks" of iron oxide is worthless for electrical insulation. That this is not the case is proved by the continued production of such mica from some of the mines of the United States and its use by large and reputable manufacturers. Many manufacturers use this mica in apparatus employing currents of less than 1,000-volt pressure with satisfactory results. Tests made on domestic "specked" mica have shown a capacity to withstand currents of much greater voltage. The black "speck" of most domestic mica is caused by extremely thin magnetite dendrites between the laminæ. These dendrites are in some mica so thin as to be transparent and apparently do not penetrate the mica sheets.

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[1] Min. World, Feb. 3, 1912.

They do not detract greatly from the insulating capacity of the mica. The ill favor with which black "specked" mica has been regarded arose from troubles caused by certain imported mica in which inclusions of metallic minerals penetrate the laminæ, thereby destroying the insulating qualities.

A large quantity of scrap mica—small sheets and the waste from the manufacture of sheet mica—is ground for different uses. Among these are the decoration of wall paper and the manufacture of lubricants, fancy paints, and molded mica for electrical insulation. Ground mica applied to wall papers gives them a silvery luster. When mixed with grease or oils finely ground mica forms an excellent lubricant for axles and other bearings. Mixed with shellac or special compositions ground mica is molded into desired forms and is used in insulators for trolley wires. Ground mica for electrical insulation must be free from metallic minerals. Mica used for lubrication should be free from gritty matter. For wall papers and brocade paints a ground mica with a high luster is required, and such luster is best obtained by using a clean light-colored mica and grinding it under water. Coarsely ground or "bran" mica is used to coat the surface of composition roofing material to prevent the tar or other composition used in its manufacture from sticking when the material is rolled for shipping.

PRODUCTION.

The total value of the mica produced in the United States in 1911 was $355,804. The production came from seven States—North Carolina, South Dakota, New Hampshire, Alabama, New Mexico, Colorado, and Virginia, named in the order of the value of their output. With the exception of Alabama and Virginia, all these States reported a production during 1910. The value of the production of mica in 1911 was greater by $18,707 than in 1910, but was less by $36,307 than in 1907.

The production of sheet mica amounted to 1,887,201 pounds, valued at $310,254, a decrease of 588,989 pounds in quantity and an increase of $26,422 in value, compared with the output of 1909. The apparent discrepancies in the figures of production in 1910 and 1911 are due to two chief causes. These are an increase in the size of sheet mica produced and a more advanced stage of preparation for the market by the producers than heretofore.

The production of scrap mica amounted to 3,512 short tons, valued at $45,550, a decrease of 553 tons in quantity and of $7,715 in value.

The value of the production of mica in North Carolina in 1911 was $217,299, as compared with $230,460 in 1910. The production reported in 1911 consisted of 454,653 pounds of sheet mica, valued at $187,501, and 2,347 tons of scrap mica, valued at $29,798; in 1910 the production consisted of 455,020 pounds of sheet mica, valued at $193,223. The output in 1911 came from Mitchell, Yancey, Jackson, Macon, Haywood, Buncombe, and Ashe counties. There are a large number of small producers of mica and several large firms operating in North Carolina. In the other States the output of mica comes from a few producers. A large increase of production of mica was reported from New Hampshire in 1911, the total value produced amounting to $44,927.

The production of mica in the United States since 1880 is shown in the following table:

Production of mica in the United States, 1880-1911.

Year.	Rough trimmed and cut mica.		Scrap mica.		Total value.
	Quantity.	Value.	Quantity.	Value.	
	Pounds.		*Short tons.*		
1880	81,669	$127,825	....	....	$127,825
1881	100,000	250,000	....	....	250,000
1882	100,000	250,000	....	....	250,000
1883	114,000	285,000	....	....	285,000
1884	147,410	368,525	....	....	368,525
1885	92,000	161,000	....	....	161,000
1886	40,000	70,000	....	....	70,000
1887	70,000	142,250	....	....	142,250
1888	48,000	70,000	....	....	70,000
1889	49,500	50,000	....	....	50,000
1890	60,000	75,000	....	....	75,000
1891	75,000	100,000	....	....	100,000
1892	75,000	100,000	....	....	100,000
1893	51,111	....	156	....	88,929
1894	35,943	....	191	....	52,388
1895	44,325	....	148	....	55,831
1896	49,156	65,441	222	$1,750	67,191
1897	82,676	80,774	740	14,452	95,226
1898	129,520	103,534	3,999	27,564	131,098
1899	108,570	70,587	1,505	50,878	121,465
1900	456,283	92 758	5,497	55,202	147,960
1901	360,060	98,859	2,171	19,719	118,578
1902	373,266	83,843	1,400	35,006	118,849
1903	619,600	118,088	1,659	25,040	143,128
1904	668,358	109,462	1,096	10,854	120,316
1905	924,875	160,732	1,126	17,856	178,588
1906	1,423,100	252,248	1,489	22,742	274,990
1907	1,060,182	349,311	3,025	42,800	392,111
1908	972,964	234,021	2,417	33,904	267,925
1909	1,809,582	234,482	4,090	46,047	280,529
1910	2,476,190	283,832	4,065	53,265	337,097
1911	1,887,201	310,254	3,512	45,550	355,804

PRICES.

The average price of sheet mica in the United States during 1911, as deduced from the total production, was 16.4 cents per pound, compared with 11.5 cents per pound in 1909. The average price of sheet mica in North Carolina was 41 cents per pound; in South Dakota, 7.2 cents; in New Hampshire, 12.1 cents. The average price of scrap mica in 1911, as deduced from the total production, was $12.97 per ton, as compared with $13.10 in 1910, and with $11.26 in 1909. The price of scrap mica in North Carolina was $12.69 per ton; in South Dakota, $13.30 per ton; in New Hampshire, $13.68 per ton.

IMPORTS.

The imports of unmanufactured and trimmed sheet mica into the United States during 1911, as reported by the Bureau of Statistics of the Department of Commerce and Labor, amounted to 1,328,768 pounds, valued at $502,163. These imports were less than those of 1910 by 632,755 pounds in quantity and $222,362 in value. Ground mica to the value of $3,389 was imported in 1911, as against $1,298 in 1910.

The quantity and value of mica imported into the United States annually from 1905 to 1911, inclusive, are shown in the following table:

Mica imported and entered for consumption in the United States, 1905–1911, in pounds.

Year.	Unmanufactured.		Cut or trimmed.		Total.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
1905	1,506,382	$352,475	88,188	$51,281	1,594,570	$403,756
1906	2,984,719	983,981	82,019	58,627	3,066,738	1,042,608
1907	2,226,460	848,098	112,230	77,161	2,338,690	925,259
1908	497,332	224,456	51,041	41,602	548,373	266,058
1909	1,678,482	533,218	168,169	85,595	1,846,651	618,813
1910	1,424,618	460,694	536,905	263,831	1,961,523	724,525
1911	1,087,644	346,477	241,124	155,686	1,328,768	502,163

FOREIGN PRODUCTION.

INDIA.

Consul-General William H. Michael,[1] of Calcutta, reports an increasing annual export of mica from India. During the fiscal year 1910–11 the value of exports was $944,915, as compared with $774,890 in 1909–10 and with $634,170 in 1908–9. Advance figures of production of mica in India during 1910, furnished by letter from the Geological Survey of India, give an output of 22,699.5 hundredweights, valued at £54,427. Two principal areas supply the mica. These are the Nellore district of the Madras Presidency and a section about 12 miles wide and 60 miles long in the Province of Bengal.

Mica is generally mined in India by underhand stoping from the surface, and in some places the vein is followed to depths of 300 feet. The mica excavated is brought to the surface by coolies on bamboo ladders. Before commencing work in the morning it is often necessary to bail the water from the mines. Concerning the labor employed at the mines Consul General Michael says:

> There are probably about 14,000 people working in the mica mines of India. They receive from 2 annas to 10 annas (4 to 20 cents) per day. The men, women, and children working in the mines board and lodge themselves on this small per diem. The death rate in the mica mines of India is placed by the last statistics on the subject at a little over one per thousand.

CANADA.

The production of mica in Canada[2] during 1911 was valued at $119,863, compared with $190,385, the revised figures for 1910. The exports of mica during 1911 amounted to 693,940 pounds, valued at $242,548, compared with 937,263 pounds, valued at $330,903, in 1910.

TRANSVAAL.

A production of mica valued at £200 during the fiscal year 1909 and at £287 during 1910 is reported from Transvaal,[3] South Africa. A large amount of unorganized work has been done on the Oliphant River mica deposits, but the mining industry has not been prosperous. The completion of the railway under construction into this region is expected to stimulate mica mining.

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[1] Daily Cons. and Trade Repts., Oct. 30, 1911, p. 523.

[2] Preliminary report on the mineral production of Canada in 1911, Dept. Mines, Canada.

[3] Ann. Rept. Govt. Min. Eng., Transvaal, 1910.

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MINERAL WATERS.

By George Charlton Matson.

INTRODUCTION.

The statistics presented in this paper are based on the commercial value of the mineral waters when they are ready for the market, and the report is confined to a discussion of those mineral waters that are sold. Certain types of waters are excluded, among them the public supplies, even though some of the supplies utilize water that is more highly mineralized than many of the waters included in this report. As far as possible, an endeavor has been made to exclude those mineral waters that have been subjected to considerable change, but the line of demarcation between natural and artificial waters is necessarily arbitrary. The essential characteristics of the mineral waters included in this report are that they shall be either natural or only slightly changed from their natural state, and that they shall be sold. Thus the term "mineral waters" is made to include every gradation from waters containing a very high percentage of inorganic substances to those that have only a very small percentage of material in solution, and there is, moreover, no systematic distinction between waters sold for medicinal purposes and those marketed for use as table waters.

It has been found impracticable by the writer to formulate a satisfactory classification of mineral waters for use in this report and consequently the classification formerly employed in similar papers has been retained. A satisfactory classification based on scientific principles is difficult to frame, for the waters under discussion vary greatly in both quantity and quality of dissolved solids, and in addition to the natural differences, some of the waters are subjected to change by artificial treatment, such as the addition of mineral salts, the addition of carbonic acid gas, or the partial evaporation of the natural water to increase the proportion of inorganic matter in the remainder.

MEDICINAL AND TABLE WATERS.

On the basis of use, the mineral waters discussed in this report are separated into two groups, those sold for their therapeutic value (medicinal waters), and those sold for use as pure drinking water (table waters). This method of classification does not permit sharp distinctions, because many of the medicinal waters contain a very small percentage of inorganic matter in solution and some of the table waters are highly mineralized. In contrasting the two groups, however, it is found that the average percentage of mineralization is greater in the medicinal waters than in the table waters. Because of the fact that the consumption of an ample supply of pure water is commonly beneficial, many of the so-called table waters may, under some circumstances, be valuable for their therapeutic effects.

The most common types of medicinal waters are those containing lithia, hydrogen sulphide, and sulphates, though in recent years certain other waters have attracted a great deal of attention because of their radioactivity. Examination has shown that a large number of natural waters exhibit more or less radioactivity and possibly possess medicinal qualities on that account. Doubtless the radium emanations of some western thermal waters are high. In order to derive the full benefit from waters of this character it would probably be necessary to utilize them at their source, because the radioactivity diminishes rapidly after the water emerges from the earth.

Sulphur waters contain a varying percentage of hydrogen sulphide gas, which gives them a disagreeable odor. Owing to the fact that the gas escapes rapidly, most of these waters are consumed at the springs, though some of them are bottled. It is doubtful if hydrogen sulphide has important medicinal qualities, but it is commonly found in waters that are highly mineralized and probably the therapeutic value of such waters depends largely upon some of the other substances in solution.

Sulphate waters contain the sulphate radicle together with several other radicles and bases—magnesium, sodium, and calcium being prominent among the latter. The laxative effect of these waters may be increased by the concentration of the inorganic substances by evaporation. The efficacy of some sulphate waters is increased by the addition of magnesium sulphate (Epsom salts) or sodium sulphate (Glauber's salts).

Large quantities of water are sold for table use, and the supplies from many important springs are utilized for domestic consumption. In general, these waters are not highly mineralized, though in some places water sold for table use contains considerable quantities of dissolved substances and might find a ready market for medicinal purposes. Table waters may be grouped as natural, or "still" waters, which are marketed in the condition in which they emerge from the earth, and carbonated waters, which have been artificially charged with carbonic acid gas. Owing to the difference in price, the demand for the former is much greater than for the latter. Still waters are often sold for less than 10 cents a gallon; carbonated waters may be valued at four or five times as much.

SOURCE AND MINERALIZATION OF WATERS.

With the possible exception of some thermal and salt springs, rainfall is the ultimate source of all mineral waters. The meteoric waters are practically pure; the mineralization takes place after they enter the ground. In their progress through the earth these waters encounter a great variety of soluble material, consequently the kind of material in solution in different waters may vary greatly. Likewise the quantity of soluble material encountered is variable, and hence the quantity of material in solution differs greatly. The freedom of circulation and the distance the underground water percolates affect both the quantity and the quality of the mineralization, because where the water is long in contact with soluble substances it is enabled to dissolve them in large quantities, and in some localities there is apparently a redeposition of some materials and a solution of others, so that the composition of the water becomes changed. An excellent example of this change is shown by some of the wells on the Atlantic Coastal Plain. Wells located near the outcrop of a water-bearing bed and receiving water that has moved a relatively short distance underground yield what is ordinarily termed "hard water," other wells, located at a greater distance from the intake, yield alkaline water from the same bed.

It is possible that some thermal springs located in regions of recent volcanic activity are supplied with water from beds of molten lava, for it is a well-known fact that water occurs in magmas that came from within the earth, and that in the processes of cooling and consolidation the included water is set free. Such springs are comparatively rare, and it is impossible to differentiate them from thermal springs arising from beds that have been heated by being in proximity to the lava. It has also been suggested that the fracturing and movement of strata produce sufficient heat to account for some thermal springs.

Some of the saline springs may be supplied from oceanic waters included in sedimentary rocks at the time of their deposition, or introduced into porous beds that have been submerged beneath the sea. Other saline springs derive their salt and like substances by solution from formations through which they have passed. Inasmuch as the strata of different localities have the same general composition it follows that there may be general groupings of mineral waters according to the character of the beds through which they have passed. However, there is apt to be great variation in the relative quantity of different substances dissolved and consequently the classification of mineral waters based on the character of the water-bearing beds would necessarily be artificial.

MARKET VALUE OF MINERAL WATERS.

As in previous reports of this series, the statistics given are based on the average selling price of water at the spring. The figures are those furnished by the spring owners and represent as nearly as possible the amounts received for the water exclusive of the price charged for the containers. There is a noticeable range in the price of mineral waters, the cheapest being those table waters that are sold in jugs and barrels, and the highest priced being carbonated table waters that are put up in bottles. Owing to these variations in price, the average for a State has little significance, but the total values are useful because they show the relative amounts paid for waters for different purposes and the relative magnitude of the mineral water business in different States. Because of the fact that statistics are not always received from all springs, the total value of the mineral waters sold is slightly greater than the figures shown by the statistics.

It has been found impossible to determine with accuracy the value of the mineral waters consumed, because the statistics furnished show only the quantity and value of the waters sold and give no idea of the quantity given away at the springs. That the value of the waters given away is large can scarcely be questioned, as many owners and managers of springs maintain hotels and other places of entertainment whose guests are not required to pay for the water consumed. Furthermore, a large quantity of mineral water is classed as artificial, because it has been changed by the addition of mineral salts or carbonic acid gas, and the statistics concerning this type of waters are incomplete.

MINERAL WATER TRADE IN 1911.

OUTPUT AND VALUE.

Traffic in mineral waters in 1911 exhibited an increase in comparison with that of 1910, but fell short of the business done in 1909, in which year the number of commercial springs, the quantity of mineral water sold, and the value of the sales reached the highest record made. The total sales of mineral waters in 1911 amounted to 63,923,119 gallons, valued at $6,837,888, compared with 62,030,125 gallons, valued at $6,357,590 in 1910. The increase in 1911 was 1,892,994 gallons, or 3.05 per cent, in quantity and $480,298, or 7.55 per cent, in value. The average price, which had declined from 11 cents per gallon in 1909 to 10 cents per gallon in 1910, advanced to 10.7 in 1911. The number of springs reporting sales in 1911 was 732, against 709 in 1910, an increase of 23. In 1909 there were 760 springs reporting, and the quantity of water sold was 64,674,486 gallons, valued at $6,894,134. The sales in 1909 exceeded those of 1911 by 751,367 gallons in quantity and by $56,246 in value. The springs which reported in 1910 and did not report in 1911 had a total production of 950,000 gallons. The following table shows the output of mineral waters in the United States in 1883, in each five years from 1885 to 1905, and annually since 1906.

Estimated production of mineral waters, 1883–1911.

Year.	Number of springs.	Quantity sold (gallons).	Value.	Year.	Number of springs.	Quantity sold (gallons).	Value.
1883	189	7,529,423	$1,119,603	1906	[a] 582	48,108,580	$8,028,387
1885	224	9,148,401	1,312,845	1907	[a] 584	52,060,520	7,331,503
1890	273	13,907,418	2,600,750	1908	[a] 695	55,868,820	6,712,680
1895	370	21,463,543	4,254,337	1909	[a] 760	64,674,486	6,894,134
1900	561	45,276,995	5,791,805	1910	[a] 709	62,030,125	6,357,590
1905	[a] 564	46,544,361	6,491,251	1911	[a] 732	63,923,119	6,837,888

[a] Springs reporting sales.

The following tables show the production by States in 1910 and 1911, with the value of the waters sold for medicinal purposes and as table waters. The number of springs reporting in each State is also shown. The quantity and value of waters used in the manufacture of soft drinks is not included in these tables nor in the preceding one.

Production and value of mineral waters in the United States, 1910 and 1911, by States.

1910.

State.	Number of springs reporting sales.	Quantity sold (gallons).	Average retail price per gallon at spring.	Value of medicinal waters.	Value of table waters.	Total value of mineral waters.
Alabama	9	133,159	$0.23	$23,179	$7,460	$30,639
Arkansas	10	1,065,676	.08	34,439	55,333	89,772
California	41	2,008,697	.20	137,491	257,350	394,841
Colorado	14	1,638,984	.07	22,133	93,156	115,289
Connecticut	24	1,608,775	.06	5,034	104,819	109,853
Florida	9	90,189	.16	2,019	12,250	14,269
Georgia	11	734,135	.09	37,172	25,999	63,171
Illinois	16	1,117,620	.07	2,485	80,663	83,148
Indiana	15	754,111	.68	493,680	21,278	514,958
Iowa	6	253,100	.11	7,400	19,775	27,175
Kansas	17	591,004	.14	64,677	17,630	82,307
Kentucky	12	403,736	.14	32,512	22,683	55,195
Louisiana	4	2,313,000	.07	10,155	153,820	163,975
Maine	29	1,238,171	.33	10,836	393,703	404,539
Maryland	8	1,163,828	.09	0	102,371	102,371
Massachusetts	55	4,691,159	.05	23,659	218,290	241,949
Michigan	17	1,454,020	.05	100	69,438	69,538
Minnesota	19	9,962,370	.03	4,585	276,424	281,009
Mississippi	7	309,450	.14	40,632	3,343	43,975
Missouri	27	657,035	.15	67,547	28,941	96,488
Nebraska	3	12,785	.12	750	779	1,529
New Hampshire	10	706,828	.29	184,817	18,014	202,831
New Jersey	11	1,583,050	.08	1,175	131,964	133,139
New Mexico	5	171,600	.18	7,380	22,780	30,160
New York	46	8,780,903	.10	167,022	691,613	858,635
North Carolina	15	143,007	.15	18,719	2,670	21,389
Ohio	30	2,226,188	.04	19,094	76,895	95,989
Oklahoma	4	115,000	.04	3,050	1,900	4,950
Oregon	7	88,970	.26	5,254	17,735	22,989
Pennsylvania	44	2,536,337	.09	49,423	172,262	221,685
Rhode Island	8	528,725	.07	0	34,703	34,703
South Carolina	15	410,691	.19	60,241	18,224	78,465
Tennessee	18	950,511	.07	60,822	10,307	71,129
Texas	31	1,241,248	.10	98,583	29,966	128,549
Vermont	5	137,875	.12	3,575	13,085	16,660
Virginia	40	2,441,923	.13	153,633	147,890	301,523
Washington	4	31,200	.40	3,530	9,041	12,571
West Virginia	13	336,444	.24	61,595	20,147	81,742
Wisconsin	36	6,400,812	.15	88,383	885,983	974,366
Other States [a]	14	997,809	.08	1,235	78,890	80,125
Total	709	62,030,125	.10	2,008,016	4,349,574	6,357,590

1911.

State.	Number of springs reporting sales.	Quantity sold (gallons).	Average retail price per gallon at spring.	Value of medicinal waters.	Value of table waters.	Total value of mineral waters.
Alabama	10	205,854	$0.15	$20,244	$6,738	$26,982
Arkansas	8	1,560,157	.07	68,554	50,440	118,994
California	40	2,310,237	.25	168,351	410,088	578,439
Colorado	14	1,436,066	.07	23,564	81,199	104,763
Connecticut	28	2,164,701	.08	5,843	176,901	182,744
Florida	9	114,416	.17	4,650	14,680	19,330
Georgia	15	981,080	.10	31,430	66,322	97,752
Illinois	14	1,304,950	.06	7,606	74,724	82,330
Indiana	15	1,084,428	.60	639,257	14,384	653,641
Iowa	6	176,000	.12	600	19,900	20,500
Kansas	18	456,341	.14	52,610	10,453	63,063
Kentucky	13	423,729	.12	25,782	24,045	49,827
Louisiana	5	1,520,550	.07	12,248	98,750	110,998
Maine	28	1,254,783	.34	11,029	420,711	431,740
Maryland	12	1,657,756	.09	3,000	147,966	150,966
Massachusetts	56	4,610,474	.05	20,459	198,411	218,870
Michigan	19	1,713,401	.04	12,156	60,097	72,253
Minnesota	17	8,703,319	.03	4,750	265,289	270,039
Mississippi	8	346,500	.22	67,050	8,000	75,050
Missouri	25	542,892	.16	57,303	29,444	86,747
Montana	4	74,750	.08	25	5,963	5,988
Nebraska	3	21,641	.09	505	1,420	1,925
New Hampshire	6	406,660	.34	125,034	14,096	139,130
New Jersey	12	2,233,627	.09	1,020	209,103	210,123
New Mexico	5	226,333	.18	33,400	8,433	41,833
New York	51	10,245,261	.09	92,554	846,449	939,003
North Carolina	16	231,510	.13	22,123	8,985	31,108

[a] Includes Delaware, District of Columbia, Idaho, Montana, Nevada, North Dakota, South Dakota, Utah, and Wyoming.

Production and value of mineral waters in the United States, 1910 and 1911, by States—Continued.

1911.

State.	Number of springs reporting sales.	Quantity sold (gallons).	Average retail price per gallon at spring.	Value of medicinal waters.	Value of table waters.	Total value of mineral waters.
Ohio	28	1,958,547	$0.04	$14,530	$71,948	$86,478
Oklahoma	10	497,074	.03	3,169	11,121	14,290
Oregon	7	56,300	.32	3,900	14,100	18,000
Pennsylvania	41	2,327,732	.09	42,914	173,905	216,819
Rhode Island	8	503,360	.05	0	27,036	27,036
South Carolina	15	285,389	.15	37,095	5,004	42,099
South Dakota	3	13,400	.18	550	1,860	2,410
Tennessee	19	1,073,115	.07	50,993	21,482	72,475
Texas	40	1,637,932	.10	124,766	33,601	158,367
Vermont	4	25,200	.37	3,111	6,235	9,346
Virginia	43	2,474,918	.13	116,052	182,649	298,701
Washington	5	148,800	.10	5,600	9,054	14,654
West Virginia	10	259,686	.26	50,155	17,532	67,687
Wisconsin	31	5,716,162	.17	93,023	862,965	955,988
Other States[a]	11	938,088	.07	2,038	67,362	69,400
Total	732	63,923,119	.11	2,059,843	4,778,845	6,837,888

[a] Includes Delaware, District of Columbia, Idaho, Nevada, North Dakota, Utah, and Wyoming.

Examination of the foregoing table will show that the rank of the various States varies according to whether the total number of springs reporting sales, the quantity of water sold, or the value of the sales, (medicinal or table waters) is selected as the basis of comparison. The relative importance of the 10 leading States is given in the following table:

Rank of 10 leading States based on springs reporting, on quantity sold, and on value of output, 1911.

	Number of springs reporting.	Quantity sold.	Value of medicinal waters.	Value of table waters.	Total value.
1	Massachusetts	New York	Indiana	Wisconsin	Wisconsin.
2	New York	Minnesota	Virginia	New York	New York.
3	Virginia	Wisconsin	California	Maine	Indiana.
4	California	Massachusetts	Texas	California	California.
5	Pennsylvania	Virginia	Wisconsin	Minnesota	Maine.
6	Texas	Pennsylvania	New York	New Jersey	Virginia.
7	Wisconsin	California	Arkansas	Massachusetts	Minnesota.
8	Maine	New Jersey	Mississippi	Connecticut	Pennsylvania.
9	Connecticut	Connecticut	Missouri	Virginia	Massachusetts.
10	Ohio	Ohio	Kansas	Pennsylvania	New Jersey.

Massachusetts leads in the number of springs reporting sales, but ranks fourth in the quantity of water sold and ninth in the value of the product. New York leads in the quantity of water sold, with a total of 10,245,261 gallons, while Minnesota, which ranked first in 1910, took second place in 1911, with sales amounting to 8,703,319 gallons. Minnesota's production in 1911 was from 17 springs, whereas New York's reports came from 51 springs, just three times the number reporting from Minnesota. The number of springs reporting from Massachusetts was 56. New York, Minnesota, and Wisconsin were the only three States reporting sales of over 5,000,000 gallons, and only one other, Massachusetts, exceeded 3,000,000 gallons. The aggregate sales from these four States amounted to 29,275.216 gallons, or 45.8 per cent of the total for the United States

In the value of the waters sold for medicinal purposes, Indiana, which does not appear in the first two columns nor in the fourth, stands far in the lead, having an output of therapeutic waters nearly four times as large as California, which ranked second. The value of the medicinal waters sold in Indiana in 1911 was $639,257, California's production was valued at $168,351.

Wisconsin leads in the value of table waters, with sales in 1911 amounting to $862,695, followed closely by New York with sales amounting to $846,449; Maine ranks third, with $420,711; California fourth, with $410,088; and Minnesota fifth, with $265,289. None of the other States exceeded $250,000, and only one, New Jersey, exceeded $200,000. Wisconsin also leads in the total value of the waters sold, the total sales in 1911 amounting to $955,988. New York ranks second, with $939,003; Indiana third, with $653,641; California fourth, with $578,439, and Maine fifth, with $431,740. The first two and last two hold their positions chiefly on account of the value of their table waters; but Indiana owes its prominence to the reputation of its medicinal waters. The most notable increase in these five States in 1911 was made by California, whose total sales of mineral waters increased from $394,841 to $578,439, or 46.5 per cent. Indiana's output also showed a substantial gain of $138,683, or 26.9 per cent. New York and Maine showed relatively small gains, and Wisconsin sales showed a slight loss.

CONDITION OF THE MINERAL-WATER TRADE.

Compared with 1910, the sales of mineral waters in 1911 showed a net gain of 1,892,994 gallons, or 3.05 per cent. The increase in value amounted to $480,298, or 7.55 per cent. The average price per gallon for the waters sold in 1911 showed a little more than a half a cent advance over 1910, the averages being, respectively, 10.7 cents and 10 cents. In all probability these differences would be modified slightly if the reports had been received from all of the commercial springs, but in each year there are a few failures to report to the Geological Survey, rarely, however, for the same spring in any two years. For such springs the production has been estimated on the basis of the records in previous years. In 1910 there were 55 springs from which no reports were received. In 1911 the delinquent springs numbered 66. The output reported by these springs in 1910 was approximately 950,000 gallons, which has been estimated in 1911 at 800,000 gallons.

Out of the 41 States in which sales were reported from more than two springs, the production increased in 24 and decreased in 17. The largest increase was in New York, which showed a gain of 1,464,358 gallons. New Jersey came second, with 650,577 gallons, and Connecticut third, with 555,926 gallons. Two of the three largest decreases were reported from the adjoining States of Minnesota and Wisconsin, the former showing a decrease of 1,259,051 gallons, and the latter of 684,650 gallons. In Minnesota there was a general decrease, most of the springs reporting fewer sales in 1911 than in 1910, and one company which reported about a million gallons in 1910 was in the hands of a receiver and had no production in 1911.

Louisiana was next to Minnesota in the quantity of decrease, with 792,450 gallons, and New Hampshire was fourth, with 300,168 gallons. There were three States in 1911 which showed increased production, but decreased values; these were Alabama, Illinois, and Kentucky. Montana showed a decrease in production with a slight increase in value.

The largest percentages of increase were in Washington, 376.92 per cent, and Oklahoma, 332.24 per cent; the largest percentages of decrease were in Vermont, 81.72 per cent, Montana, 79.12 per cent, and New Hampshire, 42.46 per cent.

In the following tables are shown the number of springs, the quantity and value of the water sold in 1910 and 1911, and the increases and decreases in the latter year:

Number of springs and quantity and value of mineral waters sold in 1910 and 1911.

State.	1910			1911		
	Springs reporting.	Quantity sold (gallons).	Value.	Springs reporting.	Quantity sold (gallons).	Value.
Alabama	9	133,159	$30,639	10	205,854	$26,982
Arkansas	10	1,065,676	89,772	8	1,560,157	118,994
California	41	2,008,697	394,841	40	2,310,237	578,439
Colorado	14	1,638,984	115,289	14	1,436,066	104,763
Connecticut	24	1,608,775	109,853	28	2,164,701	182,744
Delaware	1			1		
District of Columbia	2			2		
Florida	9	90,189	14,269	9	114,416	19,330
Georgia	11	734,135	63,171	15	981,080	97,752
Idaho	1			1		
Illinois	16	1,117,620	83,148	14	1,304,950	82,330
Indiana	15	754,111	514,958	15	1,084,428	653,641
Iowa	6	253,100	27,175	6	176,000	20,500
Kansas	17	591,004	82,307	18	456,341	63,063
Kentucky	12	403,736	55,195	13	423,729	49,827
Louisiana	4	2,313,000	163,975	5	1,520,550	110,998
Maine	29	1,238,171	404,539	28	1,254,783	431,740
Maryland	8	1,163,828	102,371	12	1,657,756	150,966
Massachusetts	55	4,691,159	241,949	56	4,610,474	218,870
Michigan	17	1,454,020	69,538	19	1,713,401	72,253
Minnesota	19	9,962,370	281,009	17	8,703,319	270,039
Mississippi	7	309,450	43,975	8	346,500	75,050
Missouri	27	657,035	96,488	25	542,892	86,747
Montana	2			4	74,750	5,988
Nebraska	3	12,785	1,529	3	21,641	1,925
Nevada	1			2		
New Hampshire	10	706,828	202,831	6	406,660	139,130
New Jersey	11	1,583,050	133,139	12	2,233,627	210,123
New Mexico	5	171,600	30,160	5	226,333	41,833
New York	46	8,780,903	858,635	51	10,245,261	939,003
North Carolina	15	143,007	21,389	16	231,510	31,108
North Dakota	1			1		
Ohio	30	2,226,188	95,989	28	1,958,547	86,478
Oklahoma	4	115,000	4,950	10	497,074	14,290
Oregon	7	88,970	22,989	7	56,300	18,000
Pennsylvania	44	2,536,337	221,685	41	2,327,732	216,819
Rhode Island	8	528,725	34,703	8	503,360	27,036
South Carolina	15	410,691	78,465	15	285,389	42,099
South Dakota	2			3	13,400	2,410
Tennessee	18	950,511	71,129	19	1,073,115	72,475
Texas	31	1,241,248	128,549	40	1,637,932	158,367
Utah	2			2		
Vermont	5	137,875	16,660	4	25,200	9,346
Virginia	40	2,441,923	301,523	43	2,474,918	298,701
Washington	4	31,200	12,571	5	148,800	14,654
West Virginia	13	336,444	81,742	10	259,686	67,687
Wisconsin	36	6,400,812	974,366	31	5,716,162	955,988
Wyoming	2			2		
States or Territories of one or two springs each, including those for which figures are not given in the above list		997,809	80,125		938,088	69,400
Total	709	62,030,125	6,357,590	732	63,923,119	6,837,888

Comparative production of mineral waters, 1910–1911.

State.	Increase (+) or decrease (−) in number of springs reporting.	Increase (+) or decrease (−) in gallons sold.	Percentage of increase (+) or decrease (−) in gallons sold.	Increase (+) or decrease (−) in value of product.	Percentage of increase (+) or decrease (−) in value of product.
Alabama	+ 1	+ 72,695	+ 54.59	− $3,657	− 11.94
Arkansas	− 2	+ 494,481	+ 46.41	+ 29,222	+ 32.55
California	+ 1	+ 301,540	+ 15.01	+183,598	+ 46.50
Colorado	....	− 202,918	− 12.38	− 10,526	− 9.13
Connecticut	+ 4	+ 555,926	+ 34.56	+ 72,891	+ 66.35
Florida	....	+ 24,227	+ 26.86	+ 5,061	+ 35.47
Georgia	+ 4	+ 246,945	+ 33.64	+ 34,581	+ 54.74
Illinois	− 2	+ 187,330	+ 16.76	− 818	− .98
Indiana	....	+ 330,317	+ 43.80	+138,683	+ 26.93
Iowa	....	− 77,100	− 30.46	− 6,675	− 24.56
Kansas	+ 1	− 134,663	− 22.79	− 19,244	− 23.38
Kentucky	+ 1	+ 19,993	+ 4.95	− 5,368	− 9.73
Louisiana	+ 1	− 792,450	− 34.26	− 52,977	− 32.31
Maine	− 1	+ 16,612	+ 1.34	+ 27,201	+ 6.72
Maryland	+ 3	+ 493,928	+ 42.44	+ 48,595	+ 47.47
Massachusetts	+ 1	− 80,685	− 1.72	− 23,079	− 9.54
Michigan	+ 2	+ 259,381	+ 17.84	+ 2,715	+ 3.90
Minnesota	− 2	−1,259,051	− 12.64	− 10,970	− 3.90
Mississippi	+ 1	+ 37,050	+ 11.97	+ 31,075	+ 70.66
Missouri	− 2	− 114,143	− 17.37	− 9,741	− 10.10
Montana	+ 2	− 283,250	− 79.12	+ 738	+ 14.06
Nebraska	....	+ 8,856	+ 69.27	+ 396	+ 25.90
New Hampshire	− 4	− 300,168	− 42.46	− 63,701	− 31.41
New Jersey	+ 1	+ 650,577	+ 41.10	+ 76,984	+ 57.82
New Mexico	....	+ 54,733	+ 31.90	+ 11,673	+ 38.70
New York	+ 5	+1,464,358	+ 16.68	+ 80,368	+ 9.36
North Carolina	+ 1	+ 88,503	+ 61.89	+ 9,719	+ 45.44
Ohio	− 2	− 267,641	− 12.02	− 9,511	− 9.91
Oklahoma	+ 6	+ 382,074	+332.24	+ 9,340	+188.69
Oregon	− 1	− 32,670	− 36.72	− 4,989	− 21.70
Pennsylvania	− 4	− 208,605	− 8.22	− 4,866	− 2.20
Rhode Island	....	− 25,365	− 4.80	− 7,667	− 22.09
South Carolina	....	− 125,302	− 30.51	− 36,366	− 46.35
South Dakota	+ 1	+ 510	+ 3.96	+ 699	+ 40.85
Tennessee	+ 1	+ 122,604	+ 12.90	+ 1,346	+ 1.89
Texas	+ 9	+ 396,684	+ 31.96	+ 29,818	+ 23.20
Vermont	− 1	− 112,675	− 81.72	− 7,314	− 43.90
Virginia	+ 3	+ 32,995	+ 1.35	− 2,822	− 0.94
Washington	+ 1	+ 117,600	+376.92	+ 2,083	+ 16.57
West Virginia	− 3	− 76,758	− 22.81	− 14,055	− 17.19
Wisconsin	− 5	− 684,650	− 10.70	− 18,378	− 1.89
Other States and Territories not included above	+ 1	+ 311,169	+ 49.63	− 3,764	− 5.14
Net increase, 1911	+22	+1,892,994	+ 3.05	+480,298	+ 7.55

SOFT DRINKS.

The manufacture and sale of beverages known as "soft drinks" is an important industry, but the statistics available are too fragmentary to furnish a definite idea concerning the magnitude of the sales. In some localities the water from mineral springs is utilized for manufacturing soft drinks. The quantity may not in all cases have been reported, but the statistics supplied show that 6,595,757 gallons were thus used in 1911, and that the total quantity of mineral water sold for all other purposes amounted to 63,923,119 gallons. The quantity of spring water used in the manufacture of soft drinks is given in the table following.

Quantity of water used in manufacture of soft drinks, 1911, by States, in gallons.

Wisconsin	2,037,258
Pennsylvania	548,296
Minnesota	504,372
Missouri	478,947
Massachusetts	376,616
Louisiana	345,000
Arkansas	340,000
Connecticut	258,900
Colorado	152,000
New Hampshire	135,484
Ohio	132,906
Michigan	130,000
South Carolina	120,285
Nebraska	110,706
Other States	924,987
Total	6,595,757

IMPORTS.

The total imports of mineral waters as reported by the Bureau of Statistics, Department of Commerce and Labor, including natural, semiartificial, and strictly artificial waters in 1911, amounted to 3,604,703 gallons, valued at $1,037,485. The valuation is that assessed by customs officials and is supposed to report the value at which the mineral waters were sold at point of shipment before any freight commissions and duties had been added. It will be noted that the imports in 1911 were nearly 300,000 gallons in quantity and over $54,000 in value in excess of those for 1910.

Mineral waters imported and entered for consumption in the United States, 1900, 1905–1911, in gallons.

Year.	Mineral waters.		Year.	Mineral waters.	
	Quantity.	Value.		Quantity.	Value.
1900	2,382,410	$663,803	1908	2,912,398	$1,033,047
1905	3,150,030	926,357	1909	3,464,524	1,085,177
1906	3,157,609	1,012,333	1910	3,306,303	983,136
1907	3,497,239	1,165,555	1911	3,604,703	1,037,485

EXPORTS.

Considerable quantities of certain domestic waters are said to be shipped to Canada and other foreign countries, but no account of such shipments is taken by the Bureau of Statistics, and no exports have been reported by the Government since 1883.

MINERAL-WATER TRADE, BY STATES.

ALABAMA.

According to the returns received from spring owners, the mineral-water trade of Alabama continued to prosper during 1911, sales increasing from 133,159 gallons reported during 1910 to 205,854 gallons in 1911, an increase of 72,695 gallons, or 54.59 per cent. The value, however, owing to a decline of 10 cents per gallon in the average price for the year, decreased 11.94 per cent, or from $30,639 in 1910 to $26,982 in 1911. No new springs were reported during 1911. Two springs which failed to report in 1910 reported in 1911, and one spring reporting in 1910 was idle in 1911; hence, the total number of springs increased from 9 to 10. About three-fourths of the total sales of mineral water in Alabama is used medicinally. There are resorts at 6 of the springs, accommodating more than 700 people, and the water at 2 is said to be used for bathing purposes. In addition to the quantity reported as sold, there were 5,000 gallons used for the manufacture of soft drinks.

The following 10 springs reported sales:

Bailey Springs, Florence, Lauderdale County.
Blount Springs, Blount Springs, Blount County.
Bromberg Gulf Coast Lithia Springs, Bayou La Batre, Mobile County.
Cherokee Spring, near Citronelle, Mobile County.
Healing Springs, Healing Springs, Washington County.
Ingram Lithia Wells, near Ohatchee, Calhoun County.
Livingston Mineral Springs, Livingston, Sumter County.
Luverne Mineral Spring, Luverne, Crenshaw County.
MacGregor Springs, Spring Hill, Mobile County.
Matchless Mineral Wells, east of Greenville, Butler County.

ARKANSAS.

Spring owners in Arkansas reported a gain in the volume of business for 1911, the total sales increasing from 1,065,676 gallons, valued at $89,772, in 1910, to 1,560,157 gallons, valued at $118,994, in 1911, a gain of over 46 per cent in quantity and of about 33 per cent in value. The average price reported was 7 cents per gallon, as against 8 cents as the average for 1910. The record for the last five years has been as follows:

Production and value of mineral waters in Arkansas, 1907–1911.

Year.	Springs reporting sales.	Quantity sold (gallons).	Value.
1907	7	431,511	$85,236
1908	10	1,175,053	212,835
1909	10	1,213,742	153,163
1910	10	1,065,676	$89,772
1911	8	1,560,157	118,994

One spring in Arkansas failed to report in 1911, 2 were idle, and 1 spring reentered the list of producing springs. There were no new springs, the total number reporting being 8, which was 2 less than in 1910. The larger proportion of the sales went for table use. There are resorts situated at 4 of the springs, and the water at 1 is used for bathing. Besides the reported sales, there is a considerable quantity of water used in the manufacture of soft drinks.

The following 8 springs reported sales:

Arkansas Lithia Springs, near Hope, Hempstead County.
Arsenic Springs, Hot Springs, Garland County.
Blue Spring, Eureka Springs, Carroll County.
Box Spring, Siloam Springs, Benton County.
De Soto Springs, Hot Springs, Garland County.
Mountain Blood Spring, near Hot Springs, Garland County.
Ozarka Spring, Eureka Springs, Carroll County.
Parnell White Sulphur Spring, Warren, Bradley County.

CALIFORNIA.

The output of mineral waters in California showed an increase, the sales reported being 2,310,237 gallons in 1911, compared with 2,008,697 gallons in 1910, an advance of 301,540 gallons, or 15 per cent. The value showed a still greater increase, from $394,841 in 1910 to $578,439 in 1911, or over 46 per cent. The record for the last five years has been as follows:

Production and value of mineral waters in California, 1907–1911.

Year.	Springs reporting sales.	Quantity sold (gallons).	Value.
1907	28	1,680,169	$460,972
1908	40	1,960,770	393,920
1909	44	2,179,187	444,230
1910	41	2,008,697	$394,841
1911	40	2,310,237	578,439

Four new springs were entered on the list during 1911—the Alma, the Barcal, the Elysian, and the Paraiso—and 2 that were delinquent in 1910 reported in 1911. Four springs reporting sales in 1910 were idle in 1911 and 3 springs failed to report in 1911, reducing the total reporting springs from 41 to 40. The water sold for medicinal purposes was valued at $168,351. Resorts are situated at 18 of the springs, accommodating nearly 4,000 patrons, and the water at 14 was used for bathing. Exclusive of the sales reported, nearly 45,000 gallons were used in the manufacture of soft drinks.

The following 40 springs reported sales:

Adams Springs, Adams, Lake County.
Ætna Spring, Lidell, Napa County.
Alhambra Spring, near Martinez, Contra Costa County.
Alma Spring, Alma, Santa Clara County.
Barcal Springs, Preston, Sonoma County.
Bartlett Spring, Bartlett Springs, Lake County.
Buckman Lithia Springs, Descanso, San Diego County.
Bythnia Spring, Santa Barbara, Santa Barbara County.
California Geysers, The Geysers, Sonoma County.
Castalian Spring, Inyo County.
Castle Rock Spring, Eubanks, Shasta County.
Console Mineral Spring, Colton, San Bernardino County.
Cooks Springs, near Williams, Colusa County.
Deer Lick Spring, Knob, Shasta County.
Duncan Springs, Hopland, Mendocino County.
El Granito Mineral Spring, El Cajon, San Diego County.
Elliotta White Sulphur Spring, Riverside, Riverside County.
Elysian Spring, Los Angeles, Los Angeles County.
Fouts Springs, Fouts Springs, Colusa County.
Joseph Mountain Spring, Corona, Riverside County.
Lepori Vichy Springs, near Napa City, Napa County.
Lytton Spring, Lytton, Sonoma County.
Napa Soda Springs, Napa Valley, Napa County.
Nuvida Springs, Sunnyside, San Diego County.
Paraiso Springs, Paraiso Springs, Monterey County.
Purity Springs, Sausalito, Marin County.
Radium Sulphur Springs, Colegrove, Los Angeles County.
San Benito Spring, near Hollister, San Benito County.
Shasta Springs, Shasta Springs, Siskiyou County.
Soboba Lithia Hot Spring, San Jacinto, Riverside County.
Spiers Spring, near Middletown, Lake County.

Tamalpais Spring, San Rafael, Marin County.
Tassajara Hot Springs, near Jamesburg, Monterey County.
Tia Juana Springs, near Nestor, San Diego County.
Tolenas Spring, near Suisun City, Solano County.
Valley Springs, Valley Springs, Calaveras County.
Veronica Medicinal Springs, near Santa Barbara, Santa Barbara County.
Vito Nuevo Spring, Mono County.
Watters Springs, Pope Valley, Napa County.
Witter Medical Springs, Witter, Lake County.

COLORADO.

There was a decrease in the mineral-water sales of Colorado during 1911, the figures reported being 1,436,066 gallons, valued at $104,763, as compared with 1,638,984 gallons sold during 1910, valued at $115,289, a loss of 202,918 gallons, or 12.38 per cent, in quantity, and of $10,526, or 9.13 per cent, in value. The change in value was not enough to affect the average price per gallon, which remained at 7 cents. The following table gives the record of the State since 1907:

Production and value of mineral waters in Colorado, 1907–1911.

Year.	Springs reporting sales.	Quantity sold (gallons).	Value.
1907	12	775,100	$154,415
1908	11	761,150	127,720
1909	15	1,077,820	111,158
1910	14	1,638,984	115,289
1911	14	1,436,066	104,763

No new springs reported during 1911, the total number remaining 14, the same as in 1910. Only about one-fifth of the total sales is used medicinally. Resorts are situated at 4 of the springs, and the water at 5 is used for bathing. Exclusive of the sales of plain or carbonated water, there were 152,000 gallons used in the manufacture of soft drinks.

The 14 reporting springs are as follows:

Boulder Springs, Crisman, Boulder County.
Canon City Soda Spring, Canon City, Fremont County.
Clark Magnetic Mineral Spring, Pueblo, Pueblo County.
Columbia Well, Denver, Denver County.
Crystal Springs, Fowler, Otero County.
Deep Rock Artesian Well, Denver, Denver County.
Dr. Horn Mineral Springs, Colorado Springs, El Paso County.
Kearney Golden Spring, near Golden, Jefferson County.
Marshall Magnetic Mineral Spring, Pueblo, Pueblo County.
Navaho, Shoshone, Manitou, and Cheyenne Springs, Manitou, El Paso County.
Pueblo Mineral Springs, Pueblo, Pueblo County.
Ute Chief Spring, Manitou, El Paso County.
Ute Iron, Ouray, and Little Chief Springs, Manitou, El Paso County.
Yampah Spring, Glenwood Springs, Garfield County.

CONNECTICUT.

Connecticut is still growing as a producer of mineral water, the sales having increased about 35 per cent in 1911 over 1910. According to the returns received there were sold during the year 2,164,701 gallons, valued at $182,744, compared with 1,608,775 gallons sold in 1910, valued at $109,853, indicating a gain of 555,926 gallons, or about 35 per cent, in quantity and of $72,891, or 66 per cent, in value. The average price per gallon was 8 cents, 2 cents more than in 1910. The record for the last 5 years is shown in the table which follows:

Production and value of mineral waters in Connecticut, 1907–1911.

Year.	Springs reporting sales.	Quantity sold (gallons).	Value.	Year.	Springs reporting sales.	Quantity sold (gallons).	Value.
1907	13	307,906	$41,439	1910	24	1,608,775	$109,853
1908	15	424,826	36,404	1911	28	2,164,701	182,744
1909	22	691,296	42,375				

Five new springs were added to the list in 1911, the Althea, the Colonial, the Foxhunter, the Gra-Rock, and the Tonica, and 1 that failed to report in 1911 is taken from the list, making a net gain of 4 and bringing the total number of springs up to 28. Only a small proportion of the total sales is used for medicinal purposes. There are no resorts at these springs, nor is the water at any used for bathing. An appreciable quantity was, however, used for the manufacture of soft drinks.

The 28 springs reporting in 1911 are as follows:

Althea Spring, Waterbury, New Haven County.
Ansantawae Spring, Milford, New Haven County.
Arethusa Spring, Seymour, New Haven County.
Berkshire Spring, Cornwall Bridge, Litchfield County.
Buttress Spring, Woodbridge, New Haven County.
Chalybeate Spring, Oxford, New Haven County.
Colonial Spring, Danbury, Fairfield County.
Crystal Spring, near Little River, Middlesex County.
Diamond Mineral Springs, Cheshire, New Haven County.
Elco Spring, Elco Springs, Hartford County.
Foxhunter Spring, Salisbury, Litchfield County.
Granite Rock Spring, Higganum, Middlesex County.
Gra-Rock Spring, Canton, Hartford County.
Hermitage Spring, Monotowese, New Haven County.
Highland Mineral Spring, Easton, Fairfield County.
Highland Spring, near Mount Higbee, Middlesex County.
Hillside Spring, West Meriden, New Haven County.
Live Oak Spring, Meriden, New Haven County.
Mystic Spring, Old Mystic, New London County.
Nonquit Spring, Fairfield, Fairfield County.
Oak Spring, Middletown, Middlesex County.
Pequabuck Mountain Spring, Bristol, Hartford County.
Red Rock Spring, Meriden, New Haven County.
Rock Ledge Spring, Monotowese, New Haven County.
Stafford Mineral Springs, Stafford Springs, Tolland County.
Tonica Spring, Highland Park, Hartford County.
Varuna Spring, North Stamford, Fairfield County.
Venture Rock Spring, Stonington, New London County.

DELAWARE.

In 1911, as in 1910, there was but one spring credited to Delaware. The water is sold chiefly in Wilmington for the table, although a considerable quantity was also used in the manufacture of soft drinks. The spring is:

Kiamensi Spring, near Wilmington, Newcastle County.

DISTRICT OF COLUMBIA.

There was a decrease in the 1911 sales of mineral waters from the two springs credited to the District of Columbia. The water from both these springs is used entirely for the table, and is sold principally in Washington. The details of output have been included with other States having less than three reporting springs.

The 2 springs are as follows:

Gitchie Crystal Spring, Benning.
Red Oak Spring, near Langdon.

FLORIDA.

The total sales from Florida show an advance during 1911, the output increasing from 90,189 gallons in 1910 to 114,416, a gain of over 26 per cent. The average price reported was 17 cents per gallon, compared with 16 cents in 1910. The total value showed a gain of about 35 per cent. There were no new springs reporting, the total number being 9, the same as in 1910. Nearly all of the water sold was for table use. There are resorts at 5 of the springs, and the water at all of these is used for bathing. Besides the total reported sales, there were 20,000 gallons used for the manufacture of soft drinks.

The following 9 springs reported sales:

Cedar Spring, near Jacksonville, Duval County.
Espiritu Santo Spring, Tampa Bay, Hillsboro County.
Lackawanna Spring, near Jacksonville, Duval County.
Magnolia Spring, Magnolia Springs, Clay County.
Newport Sulphur Spring, Newport, Wakulla County.
Orange City Mineral Spring, Orange City, Volusia County.
Panacea Mineral Spring, Panacea, Wakulla County.
Quisisana Spring, Green Cove Springs, Clay County.
Wekiwa Springs, Wekiwa Springs, Orange County.

GEORGIA.

Returns from Georgia indicate a slight increase in the trade during 1911, the sales advancing from 734,135 gallons in 1910 to 981,080 in 1911, an increase of 246,945 gallons, or about 34 per cent. The value increased in even greater ratio, from $63,171 to $97,752, a gain of $34,581, or over 54 per cent. The average price reported was 10 cents per gallon, against 9 cents in 1910. Four new springs reported for the first time, the Abbeville, the Jay Bird, the Murrow, and the Pine Mountain, the total number reporting being 15, or 4 more than in 1910. The larger proportion of the sales is used medicinally. There are resorts at 4 of the springs, with total accommodations for more than 460 people, and the water at 2 is used for bathing.

The following is the list of the 15 reporting springs:

Abbeville Spring, Abbeville, Wilcox County.
Benscot Lithia Springs, Austell, Cobb County.
Bowden Lithia Spring, Lithia Springs, Douglas County.
Catoosa Springs, Catoosa Springs, Catoosa County.
Chalybeate Spring, Chalybeate, Meriweather County.
Electric Spring, Hillman, Taliaferro County.
High Rock Spring, near Atlanta, Fulton County.
Jay Bird Spring, Beach, Ware County.
Miller's Spring, Milledgeville, Baldwin County.
Murrow Spring, Tifton, Tift County.

Pine Mountain Spring, West Point, Troup County.
Swift Lithia Spring, Elberton, Elbert County.
Utoy-Flora Spring, Utoy, Fulton County.
White Elk Spring, Macon, Bibb County.
White Oak Mineral Spring, Macon, Bibb County.

IDAHO.

But one spring reported from Idaho during 1911, the sales being practically the same as in 1910. The water from this spring is used entirely for the table. The details of output are included with other States having less than 3 producing springs. The spring reporting is:

Idanha Spring, Soda Springs, Bannock County.

ILLINOIS.

According to the returns from the spring owners of Illinois, there was a greater quantity of water sold in 1911, though at a lower value than during 1910. The output reported was 1,304,950 gallons, valued at $82,330, as compared with 1,117,620 gallons, valued at $83,148, in 1910, an increase of 187,330 gallons, or more than 16 per cent, in quantity, but a decrease of $818, or 0.98 per cent, in value. The average price per gallon was reported as 6 cents, as compared with 7 cents reported in 1910. The record for the State since 1907 is as follows:

Production and value of mineral waters in Illinois, 1907–1911.

Year.	Springs reporting sales.	Quantity sold (gallons).	Value.	Year.	Springs reporting sales.	Quantity sold (gallons).	Value.
1907	15	720,400	$91,760	1910	16	1,117,620	$83,148
1908	17	685,763	58,904	1911	14	1,304,950	82,330
1909	14	639,460	49,108				

One new spring reported sales for the first time, the Brady Spring, Joliet, Will County, the total number reporting being 14. Practically all of the Illinois spring water is used for the table. There are resorts at 4 of the springs, accommodating about 200 people, and the water at 5 is used for bathing. Besides the quantity reported as sold, there were 87,360 gallons used in the manufacture of soft drinks.

The 14 reporting springs are as follows:

Abana Mineral Springs, Libertyville, Lake County.
Aqua Vitæ Mineral Spring, Maquon, Knox County.
Brady Spring, Joliet, Will County.
Deerlick Mineral Spring, Deerfield, Lake County.
Diamond Mineral Springs, near Grantfork, Madison County.
Glen Flora Mineral Spring, Waukegan, Lake County.
Gravel Spring, near Jacksonville, Morgan County.
Greenup Mineral Spring, Greenup, Cumberland County.
Lyons Mineral Well, Greenup, Cumberland County.
Mokena Mineral Spring, Mokena, Will County.
Peoria Sulphur Springs, Peoria, Peoria County.
Sanicula Spring, Ottawa, Lasalle County.
White Diamond Spring, South Elgin, Kane County.
White Eagle Spring, Edgemont, St. Clair County.

INDIANA.

The returns as reported from spring operators in Indiana continue to indicate an increase in output. Sales during that year amounted to 1,084,428 gallons, valued at $653,641. Compared with 1910 returns of 754,111 gallons, valued at $514,958, these figures indicate a gain of over 43 per cent in quantity and of about 27 per cent in value. The average price for the year was 60 cents a gallon, 8 cents lower than 1910. As noted in previous reports of this series, the comparatively high price pèr gallon for Indiana spring water is due to the large sales of French Lick water, which as a medicinal water commands a high price. The total number of reporting springs was 15, the same as in 1910. More than 90 per cent of the total sales is used for medicinal purposes. There are 6 resorts situated at the springs, with total accommodations for more than 2,000 people, and the water at 6 is said to be used for bathing. In addition to the sales, there was a small quantity used in the manufacture of soft drinks.

The 15 reporting springs are as follows:

Blue Cast Magnetic Spring, Woodburn, Allen County.
Blue Lick Spring, Blue Lick, Clark County.
Bronson Spring, Terre Haute, Vigo County.
Carlson Mineral Springs, Laporte, Laporte County.
Cartersburg Mineral Spring, Cartersburg, Hendricks County.
Coats Spring, Logan Township, Pike County.
Colomagna Springs, Columbus, Bartholomew County.
Hunter Mineral Springs, Kramer, Warren County.
King's Mineral Spring, Dallas, Clark County.
Knott's Mineral Spring, Porter, Porter County.
Mudlavia Lithia Spring, Kramer, Warren County.
Pluto, Proserpine, and Bowles Springs, French Lick, Orange County.
Reid Mineral Spa Lithia Spring, near Richmond, Wayne County.
West Baden Mineral Springs, West Baden, Orange County.
White Crane Spring, Dillsboro, Dearborn County.

IOWA.

The mineral water trade of Iowa decreased slightly in 1911. The sales reported during 1911 amounted to 176,000 gallons, valued at $20,500, an average price of 12 cents, as compared with 253,100 gallons, valued at $27,175 in 1910, a decrease in quantity of 30 per cent and in value of over 24 per cent, the average price in 1910 being 11 cents per gallon. There was 1 new spring reporting for the first time, the Crystal Spring, at Estherville, the total number remaining the same—6. Practically the entire output was used for the table. There are no resorts at the Iowa springs, nor is the water at any used for bathing. A considerable quantity is, however, used for the manufacture of sweetened beverages.

The six reporting springs are as follows:

Colfax Mineral Wells, Colfax, Jasper County.
Council Bluffs Springs, Council Bluffs, Pottawattamie County.
Crystal Spring, Estherville, Emmet County.
Heston's Spring, Fairfield, Jefferson County.
Red Mineral Springs, Eddyville, Wapello County.
White Sulphur Spring, Davenport, Scott County.

KANSAS.

The record of the mineral-water trade of Kansas shows that 456,341 gallons were sold in 1911, with a total value of $63,063, as compared with 591,004 gallons sold in 1910, valued at $82,307, a decrease of over 22 per cent in quantity and of 23 per cent in value. The average price remained the same for the 2 years—14 cents per gallon. One spring reporting in 1911 was delinquent in 1910 and one that reported sales in 1910 failed to report in 1911. One new spring reported, the Riverview, Winfield, Cowley County, increasing the total number of commercial springs in the State to 18. More than three-fourths of the total production is sold for medicinal use. Resorts are situated at 8 of these springs, accommodating about 800 people, and the water at 7 is used for bathing. In addition to the sales, a large quantity was used for the manufacture of soft drinks.

The names of the 18 springs follow:

Abilena Spring, Abilene, Dickinson County.
Aganippe Spring, near Independence, Montgomery County.
Artesian Pure Spring, Hutchinson, Reno County.
Blasing's Natural Medical Spring, near Manhattan, Riley County.
California Spring, Ottawa, Franklin County.
Crystal Spring, Coffeyville, Montgomery County.
Geuda Springs, Geuda Springs, Cowley County.
Geyser Mineral Springs, Rosedale, Wyandotte County.
Henry Hoover Mineral Spring, Onaga, Pottawatomie County.
Magnesium and Choteau Springs, Independence, Montgomery County.
Merrill Spring, Carbondale, Osage County.
Mission Wells, Mission, Harvey County.
Phillip's Mineral Spring, Topeka, Shawnee County.
Riverview Spring, Winfield, Cowley County.
Sun Mineral Spring, Morrill, Brown County.
Sycamore Mineral Spring, Sabetha, Brown County.
Waconda Spring, Waconda Springs, Mitchell County.
Wetmore Spring, Wetmore, Nemaha County.

KENTUCKY.

There was a slight advance in the quantity of water sold in Kentucky during 1911, the sales increasing from 403,736 gallons in 1910 to 423,729 gallons in 1911, an increase of 19,993 gallons, or about 5 per cent. The value decreased slightly, the average price per gallon falling from 14 to 12 cents. One new spring reported for the first time, the Sanders Lithia, the total number being 13, or 1 more than for 1910. About one-half of the total output is used medicinally. There are resorts at 6 of the springs, and the water at 1 is used for bathing. Exclusive of the total sales, a considerable quantity was used in the manufacture of soft drinks.

The following 13 springs reported sales:

Anita Springs, La Grange, Oldham County.
Blue Lick Spring, Blue Lick Springs, Nicholas County.
Blue Rock Spring, Fisherville, Jefferson County.
Craborchard Springs, Crab Orchard, Lincoln County.
Glen Lily Spring, near Bowling Green, Warren County.
Hamby's Salts, Iron, and Lithia Springs, Dawson Springs, Hopkins County.
Lexington Lithia Springs, Lexington, Fayette County.
Robson Spring, Fort Thomas, Campbell County.
Royal Magnesian Spring, near La Grange, Oldham County.
Sanders Lithia Springs, Sanders, Carroll County.
Spring Rock Spring, Spring Lake, Kenton County.
Upper Blue Lick Springs, Upper Blue Lick, Nicholas County.
White's Epsom Spring, Crab Orchard, Lincoln County.

LOUISIANA.

The 5 commercial springs of Louisiana reported sales to the amount of 1,520,550 gallons during 1911, valued at $110,998, a decrease in quantity of 792,450 gallons, or 34 per cent, and in value of $52,977, or 32 per cent. The average price, however, remained the same, 7 cents per gallon. The record since 1908, in which year the totals were first published separately, is shown in the following table:

Production and value of mineral waters in Louisiana, 1908–1911.

Year.	Springs reporting sales.	Quantity sold (gallons).	Value.	Year.	Springs reporting sales.	Quantity sold (gallons).	Value.
1908	3	400,500	$52,020	1910	4	2,313,000	$163,975
1909	5	1,375,000	103,850	1911	5	1,520,550	110,998

No new springs reported in 1911, although a statement of production was received from 1 spring which had failed to report in 1910, making the total 5 instead of 4, as in the previous year. By far the greater portion of the water sold is used for drinking, principally in New Orleans. There are resorts at 3 of the springs accommodating about 3,000 people, and the water at 1 of these is used for bathing. Exclusive of the total sales there was an appreciable quantity used in the manufacture of soft drinks.

The 5 reporting springs are as follows:

Abita Springs, Abita Springs, St. Tammany Parish.
Geyser Well, Hammond, Tangipahoa Parish.
Greenwell Spring, Magnolia, Harrison Parish.
Krotz Well, Krotz Springs, St. Landry Parish.
Ozone Spring, Pearl River, St. Tammany Parish.

MAINE.

There was a slight advance in the volume of trade in Maine during 1911, the sales increasing 16,612 gallons, or about 1 per cent, from 1,238,171 gallons in 1910 to 1,254,783 in 1911. The value also increased slightly, from $404,539 in 1910 to $431,740 in 1911.

The record for the last five years has been as follows:

Production and value of mineral waters in Maine, 1907–1911.

Year.	Springs reporting sales.	Quantity sold (gallons).	Value.	Year.	Springs reporting sales.	Quantity sold (gallons).	Value.
1907	26	1,161,832	$414,300	1910	29	1,238,171	$404,539
1908	27	1,182,322	394,346	1911	28	1,254,783	431,740
1909	33	1,515,541	402,593				

But 1 new spring reported in 1911, the Pinecroft; 3 reporting in 1910 were delinquent, 3 were idle, and 4 old ones returned to the list of reported springs; the total number reporting, 28, being 1 less than in 1910. Only a relatively small proportion of the sales is used for medicinal purposes. Resorts are situated at 3 of the springs with accommodations for over 600 people, and the water at 2 is used for bathing. A large quantity was also used for the manufacture of soft drinks.

The 28 reporting springs are as follows:

Bakers Puritan Spring, Old Orchard, York County.
Crystal Mineral Spring, Auburn, Androscoggin County.
Forest Springs, Litchfield, Kennebec County.
Glenrock Mineral Spring, Greene, Androscoggin County.
Glenwood Spring, Augusta, Kennebec County.
Glenwood Mineral Spring, St. Albans, Somerset County.
Hanover Spring, Hanover, Oxford County.
Highland Well, Lewiston, Androscoggin County.
Indian Hermit Spring, Wells, York County.
Kennebunk Mineral Spring, Kennebunk Port, York County.
Keystone Mineral Spring, East Poland, Androscoggin County.
Mount Kebo Spring, Bar Harbor, Hancock County.
Mount Zircon Spring, Milton Plantation, Oxford County.
Mystic Spring, Saco, York County.
Oak Grove Spring, Brewer, Penobscot County.
Pine Croft Spring, Freeport, Cumberland County.
Pine Spring, Topsham, Sagadahoc County.
Poland Spring, South Poland, Androscoggin County.
Pownal Mineral Spring, New Gloucester, Cumberland County.
Raymond Spring, North Raymond, Cumberland County.
Redman Farm Spring, Belfast, Waldo County.
Rocky Hill Spring, Fairfield, Somerset County.
Seal Rock Spring, Saco, York County.
Skowhegan Spring, Skowhegan, Somerset County.
Switzer Spring, Prospect, Waldo County.
Thorndike Mineral Spring, near Thorndike, Waldo County.
Virginia Spring, Rumford, Oxford County.
Wawa Lithia Spring, Ogunquit, York County.

MARYLAND.

There was an increase in the mineral-water trade of Maryland, the output being 1,657,756 gallons in 1911, valued at $150,966, compared with 1,163,828 gallons, valued at $102,371, in 1910, an advance of 493,928 gallons, or 42 per cent, in quantity and of $48,595, or 47 per cent, in value. The average price per gallon reported for 1911 was 9 cents, the same as in 1910. The record for the last five years has been as follows:

Production and value of mineral waters in Maryland, 1907–1911.

Year.	Springs reporting sales.	Quantity sold (gallons).	Value.
1907	7	1,023,562	$110,039
1908	8	806,673	75,858
1909	7	938,496	91,569
1910	8	1,163,828	$102,371
1911	12	1,657,756	150,966

Three new springs reported in 1911, Caton Spring, Indian Spring, and Rock Crystal Spring, making the total 12, a gain of 4 over 1910. Almost the entire output of the Maryland springs is used for the table. There are resorts at two of the springs with accommodations for 90 guests, and the water at one was reported as used for bathing. In addition to the sales, a large quantity was used for soft drinks.

The following 12 springs reported sales:

Altamont Spring, near Deer Park, Garrett County.
Buena Vista Spring, Edgemont, Washington County.
Carroll Springs, Forest Glen, Montgomery County.
Castalia Spring, near Branchville, Prince Georges County.
Caton Spring, Catonsville, Baltimore County.
Chattolanee Spring, Chattolanee, Baltimore County.
Crystal Rock Spring, Berwyn, Prince Georges County.
Gneiss Rock Artesian Well, Ruxton Heights, Baltimore County.
Indian Spring, Hillsdale, Baltimore County.
Mardela Mineral Spring, Mardela, Wicomico County.
Rock Crystal Spring, Rognel Heights, Baltimore County.
Spaws Spring, Easton, Talbot County.

MASSACHUSETTS.

The mineral-water trade of Massachusetts which was less in 1910 than in 1909 suffered a further decline in 1911 the sales decreasing from 4,691,159 gallons in 1910 to 4,610,474 gallons in 1911, a decline of 80,685 gallons, or more than 1 per cent. The average price reported per gallon was 5 cents, the same as in 1910. The total value decreased from $241,949 in 1910 to $218,870 in 1911, a loss of $23,079, or about 9 per cent. The record since 1907 is shown in the following table:

Production and value of mineral waters in Massachusetts, 1907–1911.

Year.	Springs reporting sales.	Quantity sold (gallons).	Value.	Year.	Springs reporting sales.	Quantity sold (gallons).	Value.
1907	51	4,661,115	$208,579	1910	55	4,691,159	$241,949
1908	61	4,395,049	227,907	1911	56	4,610,474	218,870
1909	60	5,424,082	228,067				

Four new springs entered the list in 1911—the Leicester Polar, the New Abbott, Paradise, and Pine Crest. The total number to report was 56, or 1 more than for 1910. Less than 10 per cent of the total sales is used medicinally. There is a resort at one of the springs where the water is also used for bathing. Exclusive of the sales an appreciable quantity is used in the manufacture of soft drinks.

Following is a list of the 56 reporting springs:

Abbotts Spring, Methuen, Essex County.
Ballardvale Spring, Ballardvale, Essex County.
Belmont Crystal Spring, Belmont, Middlesex County.
Belmont Hill Spring, Everett, Middlesex County.
Burnham Spring, Methuen, Essex County.
Cadwells Crystal Spring, East Woburn, Middlesex County.
Chapmans Crystal Spring, Stoneham, Middlesex County.
Chelmsford Spring, Chelmsford, Middlesex County.
Cold Spring, Randolph, Norfolk County.
Crescent Spring, Brockton, Plymouth County.
Deep Glen Spring, West Lynn, Essex County.
Diamond Spring, Lawrence, Essex County.
El-Azhar Spring, Lowell, Middlesex County.
Everett Crystal Spring, Everett, Middlesex County.
Farrington Silver Spring, Milton, Norfolk County.
Goulding Spring, Whitman, Plymouth County.
Granite Rock Spring, Brockton, Plymouth County.
Highland Spring, West Abington, Plymouth County.
Holyoke Spring, West Lynn, Essex County.

Indian Spring, Brockton, Plymouth County.
King Philip Spring, Mattapoisett, Plymouth County.
Leicester Polar Spring, Spencer, Worcester County.
Los Altos Spring, Stoneham, Middlesex County.
Massasoit Spring, West Springfield, Hampden County.
Milton Spring, Milton, Norfolk County.
Mount Holyoke Lithia Spring, South Hadley, Hampshire County.
Mount Pleasant Spring, Lowell, Middlesex County.
Mount Vernon Spring, Lawrence, Essex County.
Nemasket Spring, Middleboro, Plymouth County.
New Abbott Spring, Methuen, Essex County.
Nobscot Mountain Spring, Framingham, Middlesex County.
Norwood Spring, Norwood, Norfolk County.
Oak Hill Spring, Brockton, Plymouth County.
October Spring, Lenox, Berkshire County.
Orient Spring, West Pelham, Hampshire County.
Paradise Spring, Rowley, Essex County.
Pearl Hill Mineral Spring, Fitchburg, Worcester County.
Pepperell Spring, Pepperell, Middlesex County.
Pine Crest Spring, Pittsfield, Berkshire County.
Pocahontas Spring, Lynnfield Center, Essex County.
Puritan Spring, Andover, Essex County.
Purity Spring, Spencer, Worcester County.
Robbins Springs, Arlington Heights, Middlesex County.
Roberge Mineral Spring, Worcester, Worcester County.
Rock Spring, Newburyport, Essex County.
Sand Spring, Williamstown, Berkshire County.
Shawmut Spring, West Quincy, Norfolk County.
Simpson Spring, South Easton, Bristol County.
Sippican Spring, Marion, Plymouth County.
Sterling Spring, West Lynn, Essex County.
Stevens Spring, Lawrence, Essex County.
Twin Elm Spring, Lexington, Middlesex County.
Valpey Spring, Lawrence, Essex County.
Whitman Spring, Whitman, Plymouth County.
Wilbraham Mountain Spring, Wilbraham, Hampden County.
Ye Cape Cod Pilgrim Spring, South Wellfleet, Barnstable County.

MICHIGAN.

The mineral-water trade of Michigan showed an advance in 1911, the quantity reported in that year being 1,713,401 gallons, compared with 1,454,020 gallons in 1910, an increase of 259,381 gallons, or nearly 18 per cent. There was only a slight gain in the value, however, of $2,715, or about 4 per cent, from $69,538 in 1910 to $72,253 in 1911. The average price per gallon declined from 5 cents in 1910 to 4 cents in 1911. The record for the last five years has been as follows:

Production and value of mineral waters in Michigan, 1907–1911.

Year.	Springs reporting sales.	Quantity sold (gallons).	Value.	Year.	Springs reporting sales.	Quantity sold (gallons).	Value.
1907	19	1,472,679	$127,133	1910	17	1,454,020	$69,538
1908	24	2,004,433	88,910	1911	19	1,713,401	72,253
1909	19	2,760,604	104,454				

Three new springs reported sales in 1911, the Arctic Lithia, the Charlevoix, and the Ossco. With the exception of about $12,000 worth used for medicinal purposes, the water sold was for the table. There were resorts at 4 of these springs, accommdoating about 900 patrons, and the water at 3 was used for bathing. In addition to the total sales a considerable quantity was used in the manufacture of soft drinks.

The 19 springs reporting sales are as follows:

Arctic Spring, Grand Rapids, Kent County.
Arctic Lithia Spring, Harvey, Marquette County.
Bromo-Hygeia Well, Coldwater, Branch County.
Charlevoix Mineral Spring, Charlevoix, Charlevoix County.
Crystal Springs, Grand Rapids, Kent County.
Cooper Farm Spring, Birmingham, Oakland County.
Eastman Springs, Benton Harbor, Berrien County.
Lake Superior Mineral Spring, Marquette, Marquette County.
No-Che-Mo Mineral Spring, Reed City, Osceola County.
Ogemaw Spring, Maltby, Ogemaw County.
Osseo Spring, Osseo, Hillsdale County.
Pantland Spring, Grand Rapids, Grand Rapids County.
Ponce de Leon Spring, Paris Township, Kent County.
Royal Oak Spring, Royal Oak, Oakland County.
St. Louis Magnetic Mineral Spring, St. Louis, Gratiot County.
Sanitas Spring, Topinabee, Cheboygan County.
Silver Springs, Grand Rapids, Grand Rapids County.
Sterling Spring, Crystal Falls, Iron County.
Victory Spring, Mount Clemens, Macomb County.

MINNESOTA.

There was a falling off in the volume of mineral-water trade in Minnesota during 1911. The sales amounted to 8,703,319 gallons, against 9,962,370 gallons reported in 1910, a decline of 1,259,051 gallons, or over 12 per cent. The total value declined somewhat less in proportion from $281,009 to $270,039, a loss of $10,970, or over 3 per cent. The average price was 3 cents, the same as in 1910. The record since 1907 is as follows:

Production and value of mineral waters in Minnesota, 1907–1911.

Year.	Springs reporting sales.	Quantity sold (gallons).	Value.	Year.	Springs reporting sales.	Quantity sold (gallons).	Value.
1907	8	9,654,030	$524,800	1910	19	9,962,370	$281,009
1908	11	10,985,536	551,986	1911	17	8,703,319	270,039
1909	20	13,746,142	614,291				

Two of the commercial springs went out of business during 1911 and no new ones reported; otherwise the same springs selling in 1910 continued to do business in 1911. But little of the Minnesota water is used medicinally. There is a resort at one of these springs and at the same spring the water is used for bathing. There was a large quantity reported as used in the manufacture of soft drinks.

The 17 reporting springs are as follows:

Clear Spring, Excelsior, Hennepin County.
Cold Spring, Cold Spring, Stearns County.
Deep Mineral Spring, Crookston, Polk County.
Donaldson Artesian Well, Minneapolis, Hennepin County.
Fifield Artesian Well, Winona, Winona County.
Glenwood-Inglewood Spring, Minneapolis, Hennepin County.
Highland Spring, St. Paul, Ramsey County.
Indian Medical Spring, Elk River, Sherburne County.
Mankato Mineral Springs, near Eagle Lake, Blue Earth County.

Minnepura Spring, Sandstone, Pine County.
Owatonna Vichy Spring, Owatonna, Steele County.
Owens Spring, Glenwood, Pope County.
Pokegama Spring, near Detroit, Becker County.
Rock Spring, Shakopee, Scott County.
Silver Spring, Marshall, Lyon County.
Swasteka Spring, Cold Spring, Stearns County.
Trio Siloam Spring, Austin, Mower County.

MISSISSIPPI.

There was an advance in the mineral-water sales of Mississippi during 1911, the output increasing almost 12 per cent in quantity. Because of the high price per gallon reported—22 cents, as compared with 14 cents reported in 1910—the total value increased to the extent of almost 71 per cent. The sales reported for 1911 were 346,500 gallons, valued at $75,050, as compared with 309,450 gallons, valued at $43,975, in 1910. Two new springs reported in 1911, the Donald and the Heidelberg Mineral Springs. Practically all of the Mississippi spring water is used medicinally. Resorts are situated at 6 of the springs, accommodating about 750 people, and the water at 1 is used for bathing.

The names of the 8 reporting springs follow:

Arundel Lithia Spring, near Meridian, Lauderdale County.
Browns Wells, near Hazelhurst, Copiah County.
Castalian Spring, near Durant, Holmes County.
Donald Spring, Vosburg, Jasper County.
Godbolds Mineral Well, Summit, Pike County.
Heidelberg Mineral Spring, Heidelberg, Jasper County.
Robinson Springs, near Pocahontas, Hinds County.
Stafford Mineral Springs, Vosburg, Jasper County.

MISSOURI.

The record of the mineral-water trade in Missouri in 1911 continued to show a falling off in both quantity and value. The reported sales amounted to 542,892 gallons, valued at $86,747, as compared with 657,035 gallons, valued at $96,488, in 1910, a decline of 114,143 gallons, or 17 per cent, in quantity and of $9,741, or 10 per cent, in value. The average price per gallon for 1911 was 16 cents, 1 cent higher than in 1910. No new springs were heard from, 1 failed to make report, 3 were idle, and 1 reported in 1911 that failed to report in 1910, thus reducing the total number of commercial springs in the State from 27 to 24. The water at 9 of the springs is used for bathing purposes. In addition to the sales an appreciable quantity was used in the manufacture of soft drinks.

The following 24 springs reported sales:

B. B. Springs, Bowling Green, Pike County.
Belcher Artesian Well, St. Louis, St. Louis City County.
Blue Lick Springs Blue Lick, Saline County.
Bokert Springs, near De Soto, Jefferson County.
Carrollton Mineral Spring, Carrollton, Carroll County.
Cusenbary Spring, near Kansas City, Jackson County.
Eagle Spring, Louisiana, Pike County.
El Dorado Springs, Eldorado Springs, Cedar County.
Grand River Mineral Spring, near Mercer, Mercer County.
Haymaker Spring, Mercer County, near Lineville, Iowa.
Hornet Mineral Springs, Bowling Green, Pike County.
Jackson Lithia Spring, Mount Washington, Jackson County.
McAllister Spring, Sedalia, Saline County.

Nek-Roc Spring, Burlington Junction, Nodaway County.
Old Orchard Spring, Old Orchard, St. Louis County.
Regent, Siloam, Soterian, and Sulpho-Saline Springs, Excelsior Springs, Clay County.
Salt Sea Well, Excelsior Springs, Clay County.
Salt Sulphur Well, Excelsior Springs, Clay County.
Sweet Springs, Sweet Springs, Saline County.
White Springs, Independence, Jackson County.
Windsor Spring, Windsor, Henry County.

MONTANA.

The total output of mineral water in Montana in 1911 was 74,750 gallons, valued at $5,988. Although 4 commercial springs reported in that year, against 2 in 1910, there was a decrease in both quantity and value. One new spring reported, Hunters Hot Spring. The water at all of these springs is principally for table use, although at one a part of it is used for medicinal purposes and at another for bathing.

The 4 reporting springs are as follows:

Hunters Hot Springs, Hunters Hot Springs, Park County.
Lissner's Mineral Spring, Helena, Lewis and Clark County.
Rock Creek Spring, Red Lodge, Carbon County.
White Sulphur Spring, White Sulphur Springs, Meagher County.

NEBRASKA.

The sales of mineral water from Nebraska during 1911 showed an increase and amounted to 21,641 gallons, valued at $1,925, an average price of 9 cents per gallon, against 12,785 gallons, valued at $1,529, an average of 12 cents per gallon, in 1910. There is a resort at 1 of the springs where the water is used also for bathing. Exclusive of the quantity sold, there were 110,706 gallons used in the manufacture of soft drinks.

The 3 reporting springs are as follows:

Brown Park Spring, South Omaha, Douglas County.
Curo Mineral Spring, South Omaha, Douglas County.
Shogo Lithia Springs, Milford, Seward County.

NEVADA.

Nevada reported production from 2 springs in 1911, as against 1 in 1910. The output of 1 spring is used for table purposes and for the manufacture of soft drinks and is the site of a resort where the water is also used for bathing. The water of the other spring is for table use only. The details of production are included with other States having less than 3 springs.

The names of the springs are:

Diamond Spring, Reno, Washoe County.
Shoshone Spring, Franktown, Washoe County.

NEW HAMPSHIRE.

Returns to the Survey indicate that the mineral-water trade of New Hampshire suffered a decline in 1911, both in quantity and in value. Reported and estimated sales amounted to 406,660 gallons, valued at $139,130, as compared with 706,828 gallons, valued at $202,831, in 1910, a decrease of 300,168 gallons, or 42.5 per cent, in quantity, and of $63,701, or 31.4 per cent, in value. No new springs were reported during 1911. There is a resort at 1 of the springs, and at one the water is used for bathing. Exclusive of the reported sales, more than 100,000 gallons were consumed in the manufacture of soft drinks. The number of reporting springs fell off from 10 in 1910 to 6 in 1911. A part of the decreased sales was due to 1 spring that was of considerable importance in 1910 reporting no sales in 1911, and to the failure of another to report.

The 6 springs are as follows:

Cohas Spring, Londonderry, Rockingham County.
Granite State Spring, Plaistow, Rockingham County.
Lafayette Mineral Spring, Derry, Rockingham County.
Mount Madison Spring, Gorham, Coos County.
White Mountain Mineral Spring, Conway, Carroll County.
Willow Spring, South Nashua, Hillsboro County.

NEW JERSEY.

According to returns from New Jersey spring owners, the mineral-water trade in that State showed a decided gain in 1911, the sales reaching a total of 2,233,627 gallons, valued at $210,123, as compared with 1,583,050 gallons, valued at $133,139, in 1910, an increase of 650,577 gallons, or 41 per cent, in quantity, and of $76,984, or 58 per cent, in value. The average price per gallon was 9 cents, a gain of 1 cent over 1910.

The record since 1907 has been as follows:

Production and value of mineral waters in New Jersey, 1907–1911.

Year.	Springs reporting sales.	Quantity sold (gallons).	Value.	Year.	Springs reporting sales.	Quantity sold (gallons).	Value.
1907	11	982,445	$103,082	1910	11	1,583,050	$133,139
1908	13	1,199,023	126,603	1911	12	2,233,627	210,123
1909	11	1,419,500	127,025				

One new spring reported during 1911, the Somerset Hill, making the total 12. Practically the entire output is used for table purposes. There are no resorts at these springs nor is the water at any used for bathing. A considerable quantity is used in the manufacture of soft drinks.

The 12 springs reporting sales are as follows:

Alpha Mineral Spring, Springfield, Union County.
Culm Rock Spring, Pluckemin, Somerset County.
Indian Spring, near Rockaway, Morris County.
Kalium Spring, Collingswood, Camden County.
Kanouse-Oakland Spring, Oakland, Bergen County.
Mount Tabor Spring, Mount Tabor, Morris County.
Pilgrim Spring, Ridgefield Park, Bergen County.
Red Rock Spring, Spring Valley Road, Bergen County.
Somerset Hill Spring, Bernardo Township, Somerset County.
Trinity Springs, Ridgefield, Bergen County.
Washington Rock Spring, Warrenville, Somerset County.
Watchung Spring, North Plainfield, Union County.

NEW MEXICO.

In 1911 the mineral-water production of New Mexico amounted to 226,333 gallons, valued at $41,833, against 171,600 gallons, valued at $30,160, in 1910, a gain of 54,733 gallons, or nearly 32 per cent, in quantity, and of $11,673, or about 39 per cent, in value. The average selling price per gallon remained the same, 18 cents. No new springs were reported in 1911. The larger proportion of the water produced was used medicinally. There were resorts at 2 of the springs which accommodated approximately 200 guests, and the water at 2 springs was said to be used for bathing. None of the springs reported water used for the manufacture of soft drinks. Returns were received from the following 5 springs:

Aztec Spring, Taylor, Colfax County.
Coyote Springs, Albuquerque, Bernalillo County.
Faywood Hot Spring, Faywood, Grant County.
Macbeth Spring, near East Las Vegas, San Miguel County.
Ojo Caliente Spring, Ojo Caliente, Taos County.

NEW YORK.

In 1911 the mineral-water trade of New York advanced to 10,245,261 gallons, valued at $939,003, compared with 8,730,903 gallons, valued at $858,358, in 1910, an increase of 1,464,358 gallons, or about 17 per cent, in quantity, and of $80,368, or a little over 9 per cent, in value. The average price per gallon, however, decreased from 10 cents in 1910 to 9 cents in 1911. The record since 1907 has been as follows:

Production and value of mineral waters in New York, 1907–1911.

Year.	Springs reporting sales.	Quantity sold (gallons).	Value.	Year.	Springs reporting sales.	Quantity sold (gallons).	Value.
1907	41	7,176,815	$686,574	1910	46	8,780,903	$858,635
1908	47	8,007,092	855,148	1911	51	10,245,261	939,003
1909	52	8,813,563	948,325				

Nine new springs reported sales in 1911, the Arlington, Clinton, Garden City, Hillside, Indian Medicinal, Mohawk, Monarch, Mount Washington, and Shannon. A total of 51 springs reported sales in 1911. With the exception of a little over $90,000 worth used for medicinal purposes, the entire quantity sold was for the table. Exclusive of the sales a considerable quantity of the water was used for soft drinks.

The following 51 springs reported sales:

Arlington Spring, Arlington, Dutchess County.
Artesian Lithia Spring, Ballston Spa, Saratoga County.
Baldwin Mineral Spring, Cayuga, Cayuga County.
Breesport Spring, Breesport, Chemung County.
Briarcliff Spring, Briarcliff Manor, Westchester County.
Chemung Spring, Chemung, Chemung County.
Chemung Valley Spring, Elmira, Chemung County.
Clinton Spring, Franklin Springs, Oneida County.
Cold Springs, New York Mills, Oneida County.
Comstock Spring, Ballston Spa, Saratoga County.

Crystal Springs, near Oswego, Oswego County.
Diamond Rock Spring, Cherry Creek, Chautauqua County.
Elixir Spring, Clintondale, Ulster County.
Elk Spring, Lancaster, Erie County.
Franklin Lithia Spring, Franklin Springs, Oneida County.
Garden City Spring, Garden City, Nassau County.
Geneva and Red Cross Mineral Springs, Geneva, Ontario County.
Gramatan Spring, Bronxville, Westchester County.
Great Bear Spring, near Fulton, Oswego County.
Hillside Spring, White Plains, Westchester County.
Indian Medicinal Spring, Madrid, St. Lawrence County.)
Lithaca Spring, Ithaca, Tompkins County.
Lithia Polaris Spring, near Boonville, Oneida County.
Mammoth Spring, North Greenbush, Rensselaer County.
Mohawk Springs, Amsterdam, Montgomery County.
Monarch Spring, Matteawan, Dutchess County.
Monarch Spring, Ballston Spa, Saratoga County.
Mount Beacon Spring, near Matteawan, Dutchess County.
Mount View Spring, Poughkeepsie, Dutchess County.
Mount Washington Spring, Hillsdale, Columbia County.
Oak Mountain Spring, near Dolgeville, Herkimer County.
Os-we-go Spring, Oswego, Oswego County.
Pleasant Valley Spring, Rheims, Steuben County.
Red Jacket Mineral Spring, Seneca Falls, Seneca County.
Red Rock Spring, Fine View, Jefferson County.
Saratoga Springs, Saratoga County:
  Arondack Spring.
  Geyser Spring.
  High Rock Spring.
  Saratoga Gurn Spring.
  Saratoga Seltzer and Emperor Springs.
Setauket Spring, Setauket, Suffolk County.
Shannon Spring, Watertown, Jefferson County.
Shell Rock Spring, near Rensselaer, Rensselaer County.
Sparkling Spring, Buffalo, Erie County.
Standard Spring, Troy, Rensselaer County.
Sun-Ray Spring, Ellenville, Ulster County.
Valley Spring, near Clayton, Jefferson County.
Vita Spring, Fort Edward, Washington County.
Washington Lithia Spring, Ballston Spa, Saratoga County.
White Sulphur Spring, Richfield Springs, Otsego County.

NORTH CAROLINA.

According to the returns received by the Survey, there was an advance in the mineral-water trade of North Carolina during 1911, the sales reported amounting to 231,510 gallons, valued at $31,108, against 143,007 gallons, valued at $21,389, in 1910, an increase of 88,503 gallons, or nearly 62 per cent, in quantity, and of $9,719, or about 45 per cent, in value. The price per gallon declined, however, from 15 cents in 1910 to 13 cents in 1911. No new springs reported during the year, the total number reporting sales being 16. The greater portion of the water sold was for medicinal use. Resorts were situated at 10 of the springs, accommodating about 1,500 patrons, and the water at 5 is said to have been used for bathing. A small quantity was used in the manufacture of soft drinks. The following 16 springs reported sales:

All Healing Spring, Alkalithia Springs, Alexander County.
Barium Rock Spring, Barium Springs, Iredell County.
Buckhorn Lithia Spring, Bullock, Granville County.
Derita Mineral Spring, near Derita, Mecklenburg County.
Haywood White Sulphur Spring, Waynesville, Haywood County.
Huckleberry Spring, Durham, Durham County.
Jackson Springs, Jackson Springs, Moore County.

Mida Spring, near Huntersville, Mecklenburg County.
Moores Springs, Moores Springs, Stokes County.
Mount Vernon Springs, Mount Vernon Springs, Chatham County.
Panacea Springs, Littleton, Halifax County.
Seven Springs, Seven Springs, Wayne County.
Shelby Lithia Spring, Shelby, Cleveland County.
Sherrill Mineral Spring, near Harrisburg, Cabarrus County.
Smith Lithia Spring, Oxford, Granville County.
Vade Mecum Spring, Vade Mecum, Stokes County.

OHIO.

The mineral-water trade of Ohio exhibited a decline in 1911. The total quantity of water reported sold was 1,958,547 gallons, compared with 2,226,188 gallons sold in 1910, a decrease of 267,641 gallons, or about 12 per cent. The value decreased $8,511, or nearly 10 per cent, from $95,989 in 1910 to $86,478 in 1911. The average price per gallon was the same in both years, 4 cents. The record for the State since 1907 has been as follows:

Production and value of mineral waters in Ohio, 1907–1911.

Year.	Springs reporting sales.	Quantity sold (gallons).	Value.	Year.	Springs reporting sales.	Quantity sold (gallons).	Value.
1907	24	1,536,621	$121,531	1910	30	2,226,188	$95,989
1908	27	2,409,598	124,938	1911	28	1,958,547	86,478
1909	31	2,709,060	112,775				

Two new springs reported sales for the first time during 1911, Fisher's Magnesia and the Sulphur, the total number reporting sales being 28. Four springs reporting in 1910 were idle in 1911, and 1 spring failed to report. The sales for medicinal purposes amounted to $14,530 in 1911, the remainder of the output sold being for table use. There were resorts at 4 of the springs, accommodating more than 3,000 patrons. The water at 4 of the resorts was said to be used for bathing. In addition to the quantity reported as sold, there were 132,906 gallons used for soft drinks.

The list of reporting springs follows:

Beech Rock Spring, near Zanesville, Muskingum County.
Bellmore Springs, near Signal, Columbiana County.
Belmont Spring, Bridgeport, Belmont County.
Chalybeate Spring, Newark, Licking County.
Collingwood Springs, Toledo, Lucas County.
Crum Mineral Spring, Austintown, Mahoning County.
Crystal Spring, Newark, Licking County.
Crystal Fountain Springs, Plainville, Hamilton County.
Deerfield Spring, Deerfield, Portage County.
Fisher's Magnesia Spring, Clintonville, Franklin County.
Highland Springs, Akron, Summit County.
Maple Grove Mineral Spring, near Chillicothe, Ross County.
Oak Place Spring, Akron, Summit County.
Oak Ridge Mineral Springs, Greenspring, Sandusky County.
Painesville Mineral Spring, Painesville, Lake County.
Peerless, Puritas, and Rockport Springs, West Park, Cuyahoga County.
Purtlebaugh Spring, Urbana, Champaign County.
Quakerdale Spring, Colerain, Belmont County.
Reynold's Artesian Well, Greenspring, Sandusky County.
Ripley Bromo Lithia Spring, Ripley, Brown County.

Sandrock Spring, Canton, Stark County.
Schoenbrun Spring, near New Philadelphia, Tuscarawas County.
Spring Grove Lithia Spring, Springfield, Clark County.
Sulphur Spring, Norwalk, Huron County.
Tallewanda Mineral Spring, College Corner, Preble County.
Wheeler Mineral Spring, Youngstown, Mahoning County.

OKLAHOMA.

There was a decided advance in the mineral-water trade of Oklahoma during 1911, the total output increasing from 115,000 gallons, valued at $4,950, in 1910, to 497,074 gallons, valued at $14,290, in 1911, a gain of 382,074, or 332 per cent in quantity, and of $9,340, or 189 per cent, in value. The average price, however, declined, being 3 cents in 1911, as compared with 4 cents in 1910.

Five new springs reported sales in 1911, the Guthriewell, Hercules, Comanche, Works Excelsior, and Sand Springs, making the total number 10. Over $3,000 worth of the water sold was for medicinal purposes. There are resorts at 2 of the springs, with accommodations for 200 guests, and the water at 5 springs was used for bathing.

The 10 reporting springs are as follows:

Bromide Well, Sulphur, Murray County.
Comanche Spring, Comanche, Stephens County.
Germicide Well Spring, Wagoner, Wagoner County.
Guthriewell, Guthrie, Logan County.
Hercules Spring, Guthrie, Logan County.
Kalium Spring, Faxon, Comanche County.
Lewis Crystalline Lithia Wells, Oklahoma City, Oklahoma County.
Sand Spring, Sand Springs, Tulsa County.
Shanoan Spring, Chickasha, Grady County.
Works Excelsior Spring, Comanche, Stephens County.

OREGON.

The returns from Oregon showed a decrease in the mineral-water trade of that State, the sales declining from 88,970 gallons, valued at $22,989, in 1910, to 56,300 gallons, valued at $18,000, in 1911, a loss of 32,670 gallons, or 37 per cent, in quantity, and of $4,989, or 22 per cent, in value. There was a gain, however, in the average price, from 26 cents in 1910 to 32 cents in 1911. No new springs reported, the total number being 7, the same as in 1910. Nearly $4,000 worth of the water was used for medicinal purposes. There are resorts at 4 of these springs, with accommodations for over 1,000 guests, and the water at 3 was used for bathing. In addition to the sales a considerable quantity was used in the manufacture of soft drinks.

The 7 reporting springs are as follows:

Ashland Lithia Springs, near Ashland, Jackson County.
Calapooya Spring, London, Lane County.
Cascade Mineral Spring, Cascadia, Linn County.
Colestin Spring, Colestin, Jackson County.
Sam-O Spring, Baker City, Baker County.
Selah Spring, Silverton, Marion County.
Siskiyou Spring, Soda Springs, Jackson County.

PENNSYLVANIA.

Pennsylvania showed a slight decline in its output of mineral waters in 1911, the quantity reported being 2,327,732 gallons, valued at $216,819, compared with 2,536,337 gallons, valued at $221,685, in 1910, a decrease of 208,605 gallons, or a little over 8 per cent in quantity, and of $4,866, or about 2 per cent in value. The average price per gallon was, however, the same in both years, 9 cents. The record of the State since 1907 has been as follows:

Production and value of mineral waters in Pennsylvania, 1907–1911.

Year.	Springs reporting sales.	Quantity sold (gallons).	Value.
1907	28	1,287,063	$235,807
1908	32	1,430,489	180,889
1909	42	2,177,967	240,856
1910	44	2,536,337	$221,685
1911	41	2,327,732	216,819

The number of new springs which reported sales in 1911 was 6, as follows: Cascade, Colonial, Dorney Park, Franklin Lithia, and Mount Hickory and Titusville. Three springs formerly reporting went out of business in 1911, 3 were idle, and 3 made no report. These changes made a total of 41 reporting springs in 1911 against 44 in 1910. The greater part of the output was used for the table. Resorts are situated at 11 of the springs, and accommodate nearly 5,000 guests. The water at 4 of the springs is used for bathing. Over 500,000 gallons were reported as used for the manufacture of soft drinks.

The following 41 springs reported sales:

Bedford Mineral Springs, near Bedford, Bedford County.
Brookside Spring, Wilkinsburg, Allegheny County.
Carnegie Alkaline and Lithia Mineral Spring, Carnegie, Allegheny County.
Cascade Spring, Erie, Erie County.
Chadwick Spring, Cambridge Springs, Crawford County.
Cloverdale Lithia Spring, near Newville, Cumberland County.
Cold Spring, Lotell, Lebanon County.
Colonial Spring, Valley Forge, Chester County.
Colvin White Sulphur Spring, Sulphur Springs, Bedford County.
De Vita Mineral Spring, Cambridge Springs, Crawford County.
Dorney Park Spring, Dorney Park, Lehigh County.
East Mountain Lithia Spring, near Factoryville, Wyoming County.
Ephrata Mountain Crystal Spring, near Ephrata, Lancaster County.
Franklin Lithia Spring, Cambridge Springs, Crawford County.
Glendale Spring, East Brook, Lawrence County.
Glenn Crystal Spring, Harbor Creek, Erie County.
Glen Summit Spring, Glen Summit Springs, Luzerne County.
Gray Mineral Spring, Cambridge Springs, Crawford County.
Harrison Valley Mineral Spring, Harrison Valley, Potter County.
Hiawatha Spring, Mount Hope, Lancaster County.
Kecksburg Artesian Mineral Spring, Kecksburg, Westmoreland County.
Keystone Spring, near Taylorsville, Bucks County.
Magnesia Springs, Cambridge Springs, Crawford County
Massassauga Mineral Spring, Erie, Erie County.
Mount Hickory Spring, Sharpsville, Mercer County.
Mount Laurel Spring, Temple, Berks County.
Petticord Spring, Cambridge Springs, Crawford County.
Pocono Mineral Spring, near Wilkes-Barre, Luzerne County.
Polar Springs, Morrisville, Bucks County.
Ponce de Leon Mineral Spring, Meadville, Crawford County.
Puritas Spring, near Erie, Erie County.
Ross Common Spring, Ross Common, Monroe County.
Salem Spring, Beach Haven, Luzerne County.
Sizerville Mineral Spring, Sizerville, Cameron County.
Springfield Spring, Springfield Township, Delaware County.
Sylvia White Sand Spring, near Seward, Westmoreland County.
Thurston's Carbonate Spring, West Mead Township, Crawford County.
Titusville Spring, Titusville, Crawford County.
Tuckahoe Mineral Spring, near Northumberland, Northumberland County.
Whann Lithia Spring, Franklin, Venango County.
White House Spring, Neversink Mountain, Berks County.

RHODE ISLAND.

The mineral-water trade of Rhode Island showed a decline in 1911, the output in that year being 503,360 gallons, valued at $27,036, compared with 528,725 gallons, valued at $34,703, in 1910, a loss of 25,365 gallons, or nearly 5 per cent, in quantity and of $7,667, or 22 per cent in value. The average price per gallon also declined from 7 cents in 1910 to 5 cents in 1911. No new springs reported, the total number being 8. The entire output of mineral water sold in the State was used for the table. There are no resorts at any of the springs, nor is the water at any used for bathing.

The following is a list of the reporting springs:

Banner Spring, Cranston, Providence County.
Berry Spring, Pawtucket, Providence County.
Crown Spring, East Providence, Providence County.
Girard Spring, North Providence, Providence County.
Gladstone Spring, Narragansett Pier, Washington County.
Holley Mineral Spring, East Woonsocket, Providence County.
Ochee Spring, Johnston, Providence County.
Prophet Spring, near Providence, Providence County.

SOUTH CAROLINA.

South Carolina showed a decrease in the mineral-water trade during 1911, the sales declining from 410,691 gallons in 1910 to 285,389 gallons in 1911, a loss in quantity of 125,302 gallons, or over 30 per cent. The value also decreased, the average price reported being 15 cents as compared with 19 cents in 1910. There were 2 new springs to enter the list, the Shivar and the Turner Magnolithia. The total number to report was 15, the same as for 1910. Three springs reporting sales in 1910 were idle in 1911, and 1, delinquent in 1910, returned to the list in 1911. Over four-fifths of the total output is used medicinally. There are resorts at 6 of the springs, accommodating about 1,000 people, and the water at 2 is said to be used for bathing. In addition to the sales reported there was a considerable quantity used in the manufacture of soft drinks.

The following 15 springs reported:

Bryan Springs, Young Island, Colleton County.
Charleston Artesian Well, Charleston, Charleston County.
Cherokee Springs, Cherokee, Spartanburg County.
Chick Springs, Chick Springs, Greenville County.
Clementia Spring, near Meggett, Colleton County.
Cokesbury Mineral Spring, near Cokesbury, Greenwood County.
Glenn Springs, Glenn Springs, Spartanburg County.
Glowing Springs, Dresden, Abbeville County.
Harris Lithia Spring, Harris Springs, Laurens County.
Piedmont Spring, Kings Creek, Cherokee County.
Rives Mineral Spring, near Lancaster, Lancaster County.
Shivar Spring, Shelton, Fairfield County.
Steele Mineral Spring, Rock Hill, York County.
Turner Magnolithia Spring, Cowpens, Spartanburg County.
Verner Spring, Greenville, Greenville County.

SOUTH DAKOTA.

The output of South Dakota increased slightly for 1911, as 3 springs reported instead of 2 as reported for 1910. There are resorts at 2 of the springs and the water at 2 is used for bathing. A large quantity is used for the manufacture of soft drinks.

The 3 reporting springs are as follows:

Minnehaha Springs, Sioux Falls, Minnehaha County.
Minnekahta Spring, Hot Springs, Fall River County.
Siloam Mineral Spring, Hot Springs, Fall River County.

TENNESSEE.

The mineral-water trade of Tennessee advanced from 950,511 gallons, valued at $71,129, in 1910, to 1,073,115 gallons, valued at $72,475, in 1911, an increase of 122,604 gallons, or nearly 13 per cent, in quantity, and of $1,346, or not quite 2 per cent, in value. The average price remained the same as in 1910—7 cents per gallon. Three new springs reported sales, the Epperson, the Larkin, and the Newbert, the total being 19. Of the total sales, $50,993 worth was for medicinal purposes. Resorts are situated at 21 of the springs, accommodating over 3,000 patrons, and the water at 4 was used for bathing.

The following list includes the 19 springs which reported sales in 1911:

East Brook Springs, Eastbrook, Franklin County.
Epperson Spring, near Westmoreland, Sumner County.
Galbraith Epsom Lithia Springs, Galbraith Springs, Hawkins County.
Gammons Spring, near Tate Spring, Grainger County.
Gladstone Spring, near Chattanooga, Hamilton County.
Hamilton Springs, near Lebanon, Wilson County.
Horn Springs, Horn Springs, Wilson County.
Idaho Springs, near Clarksville, Montgomery County.
Larkin Spring, Madison, Davidson County.
Montvale Spring, Mint, Blount County.
Newbert Spring, near Knoxville, Knox County.
Pioneer Lithia Spring, near Nashville, Davidson County.
Rhea Springs, Rhea Springs, Rhea County.
Richardsons Lockeland Spring, near Nashville, Davidson County.
Tate Spring, Tate Springs, Grainger County.
Thompson Spring, near Nashville, Davidson County.
Whittle Springs, Whittle Springs, Knox County.
Willow Brook Spring, Craggie Hope, Cheatham County.
Wright's Epsom-Lithia Spring, Mooresburg, Hawkins County.

TEXAS.

The output of mineral water in Texas in 1911 exhibited a gain of 396,684 gallons, or nearly 32 per cent, over 1910, from 1,241,248 to 1,637,932 gallons. The value increased $29,818, or more than 23 per cent, from $128,549 to $158,367. The average price per gallon remained the same as in 1910, 10 cents. The record for the State since 1907 has been as follows:

Production and value of mineral waters in Texas, 1907–1911.

Year.	Springs reporting sales.	Quantity sold (gallons).	Value.
1907	23	1,146,279	$152,233
1908	36	1,586,634	151,032
1909	34	1,033,476	98,499
1910	31	1,241,248	$128,549
1911	40	1,637,932	158,367

Nine new springs were added to the list of those reporting sales in 1911, the Crystal, Fuller, Hubbard, Hume, Myers, Rock Bottom, St. Mary's, South Austin, and Weatherby, making a total of 40. With the exception of water valued at $33,601, sold for table use, the entire output of mineral water in Texas is used for medicinal purposes. Resorts are situated at 20 of the springs, accommodating nearly 25,000 patrons, and the water at 18 is reported as used for bathing. In addition to the sales a considerable quantity is used for the manufacture of soft drinks.

The following is the list of the springs reporting sales:

Aqua Vitae Wells, Nacogdoches, Nacogdoches County.
Blossom Mineral Wells, Blossom, Lamar County.
Brock's Mineral Well, near Denton, Denton County.
Burdette Well, near Lockhart, Caldwell County.
Capp's Wells, Longview, Gregg County.
Crystal Spring, Terrell, Kaufman County.
Eureka No. 2 Well, East Weatherford, Parker County.
Farrier Spring, Dalby Springs, Bowie County.
Fuller Wells, near Hallettsville, Lavaca County.
Georgetown Mineral Wells, Georgetown, Williamson County.
Ghio Spring, Texarkana, Bowie County.
Hubbard Hot Well, Hubbard City, Hill County.
Hume Sour Water Well, Sutherland Springs, Wilson County.
Key's Wells, Salado, Bell County.
Mangum Wells, Mangum, Eastland County.
Marlin Hot Wells, Marlin, Falls County.
Maurice Wells, Mangum, Eastland County.
Mineral Wells, Palo Pinto County:
    Austin Well.
    Barber Wells.
    Crazy Well.
    Gibson Well.
    Lamar Well.
    Palo Pinto and Texas Carlsbad Wells.
    Rock Bottom Well.
    Standard Wells.
    Star Well.
Myers Mineral Well, Kirbyville, Newton County.
North Park Mineral Well, Abilene, Taylor County.
Orono Mineral Spring, Oran, Palo Pinto County.
Putnam Mineral Well, Putnam, Callahan County.
Red Mineral Springs, Mount Pleasant, Titus County.
Riviere Wells, 1, 2, and 3, Tyler, Smith County.
Roach Well, near Mount Pleasant, Titus County.
Rosborough Spring, near Marshall, Harrison County.
St. Mary's Mineral Well, near Hallettsville, Lavaca County.
Sour Wells, Sulphur Springs, Hopkins County.
South Austin Wells, South Austin, Travis County.
Tioga Mineral Wells, Tioga, Grayson County.
Weatherby Spring, Garrison, Nacogdoches County.
Woodward Vichy Spring, Rockbridge, La Salle County.

UTAH.

Although no new springs were reported in Utah for 1911, there was a large increase in both the quantity of water sold and the value received for it. The details are still included in other States having less than 3 operating springs. Neither of the 2 springs credited to the State is used as a resort. Their names are as follows:

Deseret Lithia Spring, Deseret, Millard County.
Utanah Springs, Wasatch Mountains.

VERMONT.

The output in Vermont decreased from 137,875 gallons in 1910 to 25,200 gallons in 1911, a decrease of 112,675 gallons, or 81.72 per cent. The total value decreased 44 per cent. About one-third of the total water is sold for medicinal use. No new springs reported during the year. There are resorts at 2 of the 4 springs, with accommodations for about 400 people, and the water at 1 is said to be used for bathing. Exclusive of the sales there was a considerable quantity of the water made up into soft drinks.

The 4 springs to report are as follows:

Brunswick Sulphur Springs, Brunswick, Essex County.
Clarendon Spring, Clarendon Springs, Rutland County.
Equinox Spring, Manchester, Bennington County.
Missisquoi Spring, Sheldon Junction, Franklin County.

VIRGINIA.

According to the returns from Virginia to the Survey, 2,474,918 gallons of mineral waters were sold in 1911, and their value was $298,701, compared with 2,441,923 gallons, valued at $301,523, in 1910, an increase of 32,995 gallons, or about 1 per cent, in quantity and a decrease of $2,822, or less than 1 per cent, in value. There was no change in the average price per gallon from 1910, when it was 13 cents.

The record of Virginia during the last five years is shown in the following table:

Production and value of mineral waters in Virginia, 1907–1911.

Year.	Springs reporting sales.	Quantity sold (gallons).	Value.	Year.	Springs reporting sales.	Quantity sold (gallons).	Value.
1907	44	2,442,075	$431,770	1910	40	2,441,923	$301,523
1908	46	2,009,614	207,115	1911	43	2,474,918	298,701
1909	49	1,504,530	203,455				

Two new springs were added to the list in 1911, the Lithia Magnesia and the Landale, making a total of 43 which reported. Of the mineral waters sold in Virginia in 1911, the sum of $116,052 represented the medicinal use and $182,649 the table use. There are resorts at 12 of the Virginia springs, accommodating about 1,800 patrons, and the water at 6 is used for bathing. In addition to the sales, a considerable quantity was used in the manufacture of soft drinks.

The following 43 springs reported sales:

Alleghany Spring, Alleghany Spring, Montgomery County.
Basic Spring, Basic City, Augusta County.
Bear Lithia Spring, near Elkton, Rockingham County.
Beaufont Spring, near Manchester, Chesterfield County.
Berry Hill Mineral Spring, Elkwood, Culpeper County.
Blue Ridge Springs, near Blue Ridge Springs, Botetourt County.
Bowman Spring, near Staunton, Augusta County.
Broad Rock Mineral Spring, near Richmond, Chesterfield County.
Brough Spring, Nace, Botetourt County.
Buckhead Lithia Spring, Buckhead Springs, Chesterfield County.

Buffalo Lithia Spring, Buffalo Lithia Springs, Mecklenburg County.
Burnetts Spring, Hudson Mill, Culpeper County.
Campfield Lithia Spring, Chesterfield County.
Carper Lithia Springs, Radford, Montgomery County.
Coppahaunk Lithia Springs, Waverly, Sussex County.
Crockett Arsenic Lithia Spring, Crockett Springs, Montgomery County.
Diamond Spring, Diamond Spring, Princess Anne County.
Erup Mineral Spring, near Glencarlyn, Alexandria county.
Farmville Lithia Springs, Farmville, Prince Edward County.
Fonticello Lithia Spring, near Manchester, Chesterfield County.
Harris Anti-Dyspeptic Spring, Burkeville, Nottoway County.
Iron-Lithia Springs, Tip Top, Tazewell County.
Jeffress Spring, Jeffress, Mecklenburg County.
Kayser Lithia Springs, Staunton, Augusta County.
Kiwassa Lithia Spring, near Manchester, Chesterfield County.
Landale Spring, Norfolk County.
Lithia Magnesia Spring, Rocky Mount, Franklin County.
Massanetta Spring, near Harrisonburg, Rockingham County.
Mecklenburg Spring, Chase City, Mecklenburg County.
Mico Well, Alexandria, Alexandria County.
Nye Lithia Springs, Wytheville, Wythe County.
Otterburn Lithia Spring, near Amelia, Amelia County.
Paeonian Spring, Paeonian Springs, Loudoun County.
Pickett Spring, Worsham, Prince Edward County.
Rockbridge Alum Springs, Rockbridge Alum Springs, Rockbridge County.
Rubino Healing Springs, Healing Springs, Bath County.
Seawright Spring, near Staunton, Augusta County.
Stribling Springs, Stribling Springs, Augusta County.
Tripho-Lithia Spring, Claremont, Surry County.
Virginia Etna Springs, Vinton, Roanoke County.
Virginia Magnesian Alkaline Spring, near Staunton, Augusta County.
Wallawhatoola Springs, Millboro, Bath County.
Wyrick Mineral Spring, Crockett, Wythe County.

WASHINGTON.

In the output of mineral waters in 1911 Washington exhibited a marked increase over the preceding year. In 1911 the quantity of water sold was 148,800 gallons, valued at $14,654, compared with 31,200 gallons, valued at $12,571, in 1910, an advance of 117,600 gallons, or about 377 per cent, in quantity. The value, however, increased only $2,083, or not quite 17 per cent, the average price being 10 cents, against 40 cents per gallon in 1910. Two new springs reported sales, the Artesian and the Klickitat. There was a resort at 1 of the springs, and at another the water was used for bathing.

The 5 springs reporting sales are as follows:

Artesian Spring, North Yakima, Yakima County.
Diamond Mineral Spring, Auburn, King County.
Klickitat Spring, Klickitat, King County.
Olympia Hygeian Spring, Tumwater, Thurston County.
Soda Spring, North Yakima, Yakima County.

WEST VIRGINIA.

In 1911 the mineral-water trade of West Virginia showed a decrease, from 336,444 gallons, valued at $81,742, in 1910, to 259,688 gallons, valued at $67,687, in 1911, a loss of 76,758 gallons, or about 23 per cent, in quantity and of $14,055, or more than 18 per cent, in value. The average price, however, increased from 24 to 26 cents. Two new springs entered the list of reporting springs in 1911, the Alderson and the Red Sulphur. The greater part of the total output of spring water in West Virginia is used medicinally, which accounts for the relatively high price received for the water. There are resorts at 6 of the springs, with accommodations for over 1,800 patrons, and the water at 2 is used for bathing. In addition to the sales, a small quantity was used in the manufacture of soft drinks.

The 10 reporting springs are as follows:

Alderson Spring, Alderson, Monroe County.
Borland Mineral Springs, Borland, Wood County.
Green Sulphur Spring, Green Sulphur Springs, Summers County.
Man-A-Cea Irondale Spring, Independence, Preston County.
Pence Spring, Pence Springs, Summers County.
Red Sulphur Spring, Red Sulphur Springs, Monroe County.
Saline-Chalybeate and Vigoro Spring, Woodsdale, Ohio County.
Walnut Hill Spring, near Charleston, Kanawha County.
Webster Springs, Webster Springs, Webster County.

WISCONSIN.

The State showed a decrease in the output of its mineral waters in 1911 from 6,400,812 gallons, valued at $974,366, in 1910, to 5,716,162 gallons, valued at $955,988, in the following year, a loss of 684,650 gallons, or nearly 11 per cent, in quantity and of $18,378, or practically 2 per cent, in value. The average price, however, advanced from 15 to 17 cents per gallon. The record since 1907 has been as follows:

Production and value of mineral waters in Wisconsin, 1907–1911.

Year.	Springs reporting sales.	Quantity sold (gallons).	Value.	Year.	Springs reporting sales.	Quantity sold (gallons).	Value.
1907	29	6,839,219	$1,526,703	1910	36	6,400,812	$974,366
1908	28	6,084,571	1,239,907	1911	31	5,716,162	955,988
1909	34	6,101,882	1,132,239				

One new spring, the Spring Grove Epsom, reported sales for the first time in 1911. Six springs that reported sales in 1910 were idle or out of business in 1911, and 2 made no report. The value of the table water sold during the year was $862,965, and the value of that used for medicinal purposes was $93,023. There are resorts at 4 of the springs which accommodate over 1,700 guests, and the water at 3 was used for bathing. In addition to the water sold, the manufacture of soft drinks in Wisconsin consumed 2,037,258 gallons. The following list includes the 31 springs which reported sales during 1911:

Arbutus Mineral Spring, Oconto, Oconto County.
Bay City Spring, Ashland, Ashland County.
Bethania Spring, Osceola, Polk County.
Bryant Silver Spring, Madison, Dane County.
Castalia Spring, Wauwatosa, Milwaukee County.
Chippewa Spring, Chippewa Falls, Chippewa County.
Crystal Spring, Sheboygan, Sheboygan County.
Elysian Spring, Prairie du Chien, Crawford County.
Fontana Lithia Spring, Fontana, Walworth County.
Kusche Spring, Oshkosh, Winnebago County.
Maribel Mineral Spring, Maribel, Manitowoc County.
Maskanozes Spring, Butternut, Ashland County.
Nee-Ska-Ra Spring, Wauwatosa, Milwaukee County.
St. John Mineral Spring, Green Bay, Brown County.
Sheboygan Mineral Spring, Sheboygan, Sheboygan County.

Sheridan Mineral Springs, near Lake Geneva, Walworth County.
Solon Springs, Solon Springs, Douglas County.
Spring Grove Epsom Spring, Green Lake, Green Lake County.
Waukesha Springs, Waukesha County:
  Almanaris Spring.
  Anderson's Spring.
  Arcadian Spring.
  Bethesda Spring.
  Clysmic Spring.
  Crystal Rock Spring.
  Fox Head Spring.
  Glenn Rock Spring.
  Horeb Crystal Spring.
  Minniska Spring.
  Roxo Spring.
  Silurian Spring.
  White Rock Spring.

WYOMING.

Returns from the 3 springs in Wyoming indicate but little change since 1910. One of these springs is used as a resort and at 1 the water is used for bathing. At 1 a considerable quantity is used for the manufacture of soft drinks. One new spring, the Red Rock, near Basin, reported in 1911.

The 3 springs to report are as follows:

De Maris Spring, Cody, Bighorn County.
Red Rock Spring, near Basin.
Saratoga Hot Springs, Saratoga, Carbon County.

THE CONCENTRATION OF MINERAL WATER IN RELATION TO THERAPEUTIC ACTIVITY.

By R. B. Dole.

INTRODUCTION.

The literature on mineral waters is voluminous, and many schemes for the classification of those reputed to have curative properties have been devised, yet comparatively little has been published regarding the relations between the concentration of the various dissolved substances and their effects within the human body. Peale,[1] Crook,[2] Walton,[3] and other writers on mineral waters have given almost no attention to that phase of hydrotherapeutics. Skinner's classification [4] of waters according to their saline content is based on the fact that most surface waters in the eastern part of the United States contain approximately 100 parts per million of dissolved matter and may be considered moderately mineralized. He classes waters containing more than 500 parts as very highly mineralized. Grünhut[5] has also suggested limits of concentration by which mineral water may be distinguished from common water, but further than this little has been published on the subject. The writer has found it useful in some discussions to classify as "low" the mineral content of waters carrying less than 150 parts per million of total mineral matter; as "high," a content exceeding 500 parts, and as "very high," a content exceeding 2,000 parts. This arbitrary classification is based to some extent on the relation between mineral content, industrial usefulness, and potability. Such limits, however, do not serve well in classifying waters with respect to their medicinal power, for different ions evidently act with different power. This article has therefore been prepared, not to report new experimental results, but to collate some of the widely scattered data on the physiologic and therapeutic action of the inorganic substances in natural waters and to discuss some of the relations between their concentration and their possible medicinal effects.

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[1] Peale, A. C., The classification of mineral waters: Cohen's system of physiologic therapeutics, Philadelphia, vol. 9, 1902, p. 299; Natural mineral waters of the United States: Fourteenth Ann. Rept. U. S. Geol. Survey, pt. 2, 1894, p. 49; Lists and analyses of the mineral springs of the United States: Bull. U. S. Geol. Survey No. 32, 1886.

[2] Crook, J. K., The mineral waters of the United States and their therapeutic uses, New York, 1899.

[3] Walton, G. E., The mineral springs of the United States and Canada, New York, 3d ed., 1883.

[4] Skinner, W. W., American mineral waters; the New England States: Bull. Bur. Chem. No. 139, U. S. Dept. Agr., 1911, p. 21.

[5] Grünhut, L., Regulations concerning mineral water: Balneologische Zeitung, Sept. 30, 1911; Zeitschr. öffentl. Chemie, vol. 17, 1911, p. 403.

EFFECTS OF WATER DRINKING.

The therapeutic application of water, or its use for correcting diseased conditions, has long been recognized; yet investigation shows that many supposed cures attributed to the use of mineral waters are supported by meager evidence. Indeed, the status of the problem is in some respects much as it was in 1756, when Lucas[1] wrote:

> Yet, notwithstanding this general knowledge of water, nothing seems more wanting, or more difficult to obtain, than a true and rational notion of this most beneficent fluid.

Study of analyses and other data on mineral waters yields four significant facts: First, many patients have improved in health under mineral-water treatment; second, waters of widely different chemical composition have been recommended as cures for the same disease; third, curative properties are attributed to many waters whose mineral content is the same or is lower than city supplies used daily by thousands of people without peculiar physiologic effect; fourth, treatment at resorts is very often recommended for those afflicted with chronic organic diseases, many of which are obscure in nature or are caused by failure of proper interchange between food and waste in the tissues of the body. These facts lead to the reasonable conclusion that the free use of water itself—hydrogen monoxide, the common ingredient of all these mineral solutions—is the cause of much of the apparent improvement in health, and that this agent is aided by normal regimen of diet and exercise and by other hygienic restrictions, as well as by possible change of climate and freedom from business or household cares.

The beneficial effect on the human body of water itself, both hot and cold, used internally or externally, is now so generally recognized as hardly to need exposition. Water is not only an essential ingredient of the body, necessary for organic existence, but it is also the universal cleansing agent, is the chief vehicle for the transportation of food to the tissues, and is a principal medium for removing waste. Systematic study of drinking and bathing in waters has created hydrotherapy, balneology, and crounotherapy, branches of the art of healing by application of water to the body. Treatments of that nature have been extensively discussed.[2] Nearly all reports on mineral waters contain reference, brief though it may be, to the benefits derived from water drinking, and experimental studies have shown that some of the organic changes formerly attributed to small quantities of various dissolved substances may be caused by water that does not contain these substances. The minute quantity of lithium in some waters, for example, has been believed to relieve uric-acid poisoning by forming soluble urates of lithium capable of ready excretion; but according to the National Standard Dispensatory[3] the alkaline salt of lithium has greater affinity for the acid phosphate than for the urate radicle in the blood, and therefore increased excretion of uric acid following the use of weak lithia waters may more properly be considered a result of increased activity of the kidneys following copious drinking of water. According to Fleig[1] ordinary water in the alimentary canal exerts greater diuretic action than a fairly strong solution of salt, while Hawk and his associates,[2] after extensive experiments on human subjects, have concluded that drinking large quantities of water with meals increases gastric secretion and pancreatic activity, modifies other functions, and, in short, is attended by many beneficial and no harmful results.

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[1] Lucas, Charles, An essay on waters. London, 1756, p. 23.

[2] Kellog, J. H., Rational hydrotherapy, Philadelphia, 3d ed., 1906. Winternitz, W., Hydrotherapy: Cohen's system of physiologic therapeutics, Philadelphia, vol. 9, 1902. Also in many other publications.

[3] The National Standard Dispensatory, 2d ed., compiled by Hare, Caspari, and Rusby, Philadelphia, 1909, p. 963.

No doubt can be entertained that many mineral waters have distinct physiologic effect because of the inorganic substances dissolved in them, for certain obvious reactions following the ingestion of some waters differ entirely in kind or in degree from the reactions following the drinking of slightly mineralized water. Some natural solutions are poisonous; some are cathartic; some have less obvious but demonstrable effect. The nature and the magnitude of these reactions are as much dependent on the nature and the concentration of the dissolved substances as the reactions caused by any medicine. Yet since the administration of water in one or more of many ways and at various temperatures can cause marked reactions it is pertinent to inquire how much of the therapeutic value of natural mineral waters is due to dissolved inorganic matter and how much to water itself.

ANALYSIS OF WATER.

Waters considered to have therapeutic value are carefully analyzed. As the various radicles are therefore accurately determined and the search for small quantities of unusual elements is rigidly prosecuted it is improbable that inorganic substances present in sufficient quantity to be the cause of physiolgic reactions are overlooked by careful analysts. Though the identity and the quantity of the elements and radicles are known, nevertheless the confusion and uncertainty arising from stating these comparatively exact results in different units and in hypothetical combinations have been among the principal causes of the failure properly to correlate analyses or to interpret them in respect to their therapy. Analytical methods permit the determination of the elements and radicles that are present in water and also of the total quantity of mineral matter in solution, and by various processes they allow estimation of "temporary" and "permanent" hardness, of alkalinity or acidity, and of some other properties of minor importance. They do not, however, permit determination of the exact quantities of the different salts in solution, for the analytical data are insufficient to allow apportionment of the acidic among the basic radicles to form salts, for such combinations, though made in accordance with rules that may appear reasonable or advisable, are necessarily arbitrary. Hence reports of different analysts may be so widely divergent as to be incapable of comparison with one another.

The ionic form of statement, a statement of the radicles actually determined by the analyst, avoids this difficulty by indicating facts with the least amount of theory. That form of expression is well suited to discussion of the therapeutics of the dissolved substances, for the results of experiments indicate that specific physiologic action of salts in solution is due, not to the salts as such, but to one or more of the ions in solution, and that the force of the action is more or less proportionate to the concentration of the active ions.

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[1] Fleig, C., Diuresis by ingestion, or washing produced by large quantities of water of hypotonic salt or sugar solutions: Bull. gén. thérap., vol. 160, p. 44; Centralbl. Biochem. Biophys., vol. 10, p. 713; Chem. Abstracts, vol. 5, 1911, p. 113.

[2] Hawk, P. B., and others, Studies on water drinking: Jour. Am. Chem. Soc., vol. 32, p. 1686; Jour. Exp. Med., vol. 12, 1910, p. 388; Arch. Int. Med., vol. 7, pp. 536, 610; Proc. Soc. Exp. Biol. Med., vol. 8, p. 36; Proc. Am. Physiol. Soc., 1910, p. 32.

The radicles commonly estimated in complete analysis of mineral waters are given in the following list. Some may not be present in amount sufficient for quantitive determination, and other radicles besides these may be present. Silicon (Si), which is commonly present in natural waters as a colloid, may not usually be classed as a radicle; it is conventionally expressed as the oxide, SiO_2. It is necessary, however, to assume the presence of a silicate radicle in some waters.[1]

Substances estimated in analysis of mineral waters.

Basic radicles (Cations).

Iron (Fe).
Aluminum (Al).
Manganese (Mn).
Calcium (Ca).
Strontium (Sr).
Barium (Ba).
Magnesium (Mg).
Sodium (Na).
Potassium (K).
Lithium (Li).
Ammonium (NH_4).
Hydrogen (H).

Acidic radicles (Anions).

Chloride (Cl).
Bromide (Br).
Iodide (I).
Fluoride (F).
Carbonate (CO_3).
Bicarbonate (HCO_3).
Sulphide (S).
Thiosulphate (S_2O_3).
Sulphite (SO_3).
Bisulphite (HSO_3).
Sulphate (SO_4).
Bisulphate (HSO_4)
Nitrite (NO_2).
Nitrate (NO_3).
Arsenite (AsO_2).
Arsenate (AsO_4).
Metaborate (BO_2).
Pyroborate (B_4O_7).
Orthophosphate (PO_4).
Metasilicate (SiO_3).
Hydroxide (OH).

Gases.

Carbon dioxide (CO_2).
Hydrogen sulphide (H_2S).
Oxygen (O).
Methane (CH_4).

Analyses of water evidently must be reduced to a common unit before any comparison of relative concentrations can be made. The expression of results in parts per million by weight (milligrams per kilogram) is desirable, because that form obviates uncertainty regarding the unit of measure and requires least tabulation of decimals, besides being most convenient for the analyst. Equivalents for use in transferring results from various common forms of expression into parts per million are given in the following table. If a volumetric unit is used in reporting analyses of very strong solutions, correction must be made for specific gravity by dividing the expressed weight of the substance by the specific gravity. The amounts of dissolved gases may be expressed in cubic centimeters per liter at zero centigrade and a pressure of 760 millimeters.

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[1] Clarke, F. W., The data of geochemistry, 2d ed.: Bull. U. S. Geol. Survey No. 491, 1911, p. 183.

Equivalents for converting analyses of water into parts per million.

	Equivalent in parts per million.
One part per hundred (percentage)	10,000
One part per thousand	1,000
One gram per liter	1,000
One part per hundred thousand	10
One hydrotimetric degree	10
One English degree	14.261
One grain per United States gallon	17.118
One grain per Imperial gallon	14.261
One pound per 1,000 United States gallons	119.8

MINERAL CONSTITUENTS IN RELATION TO PHYSIOLOGIC REACTIONS.

Statements regarding the therapeutic effects of the dissolved mineral ingredients have been based chiefly on empirical knowledge gained by observing the results after the ingestion of water and the mineral ingredients it contained. Even if it be assumed that most data of this nature are credible, the difficulty of differentiating between the effects of the mineral ingredients and the effects of diet, climate, and other changeable factors is apparent. Extensive experimental investigation of the manner and the force with which natural waters affect normal or pathologic conditions of organisms has been made only within comparatively recent years, and the advances in that line of research have been coincident with the growth of pharmacology and chemical biology. It seems reasonable to conclude from what has been done that the specific reactions caused by the radicles in natural waters are similar to those caused by the same radicles in simpler artificial solutions, that such reactions are due chiefly to the ions, and that the magnitude of the reactions depends on the ionic concentration of the solutions. In other words, the probability of medicinal action due to the dissolved substances in natural waters can be judged by comparing the concentration of such substances with equivalent concentrations of medicinal preparations whose doses have been fixed and whose properties have been investigated. If these conclusions are assumed to be justifiable, a means is afforded by which the medicinal value of the mineral ingredients of waters can be estimated.

The manner in which inorganic salts cause changes within the body has been treated at length by Cushny,[1] from whose work the following brief outline has largely been prepared. Salts have specific action on living tissues in three general ways—stimulants increase and depressants decrease the activity of an organ or a function, and irritants cause change in condition, as in form, growth, or nutrition, rather than in activity of function. These specific actions depend on the nature, not of the salts or the elements, but of the ions introduced. For example, potassium cyanide (KCN) is poisonous because of the cyanide radicle (CN); though any other soluble cyanide is poisonous, both carbon and nitrogen in other forms can be ingested without any poisonous action whatever, and if those two elements are administered in solutions in which the cyanide radicle is not present the cyanide action does not occur. The specific action of a salt may be due to one or more of its ions; the action of one ion, either basic or acidic, may be so strong that the action of the others is negligible, or both acidic and basic ions may be active, according to the nature of the substance. Besides this specific action solutions of inorganic salts affect tissues through "salt action" by changing the physical properties of the fluids within and without living cells. This alteration is chiefly through dialysis caused by difference in osmotic pressure, by reason of which fluid passes through the tissues from the weaker to the stronger solution till both have the same osmotic pressure. At the same time but with less rapidity, some of the salts in solution penetrate the tissues. Therefore, after a solution has been swallowed it takes or gives up water through the walls of the stomach and intestine according to the relative osmotic pressures of the fluids involved. All cells do not resemble each other in their permeability or in the salt which dialyzes into them, and though "salt action" is common to all solutions of all salts various fluids are diffused at different rates, and the salts dissolved in them are absorbed with different rapidity. For example, a weak (hypotonic) solution of sodium chloride rapidly gives up water through the walls of the alimentary canal, thereby supplying fluid to the blood. As the solution administered is increased in strength it yields less water until when it is very strong (hypertonic) it draws fluid through the surrounding membranes. Sodium sulphate is absorbed very slowly, and for that reason a strong solution of it acts as a laxative by drawing much fluid into the intestine and thus accelerating peristalsis. Briefly then, salts have physiologic influence both by specific action of their ions on the cells and by changing the physical condition of the fluids in contact with the cells.

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[1] Cushny, A. R., A textbook of pharmacology, 3d ed., Philadelphia, 1903.

MINIMUM DOSES OF INORGANIC SUBSTANCES.

The probable analogy between the therapeutic power of inorganic substances in natural and in artificial solutions has been employed for the purpose of ascertaining standards of concentration by which it may be judged whether a given water has therapeutic value by reason of its dissolved mineral ingredients, and if so, what the probable action of the water will be. By this method various inorganic compounds in which the same ion has strong physiologic effect have been grouped and the amount of the active radicle has been computed from the minimum doses of those compounds. That amount has then been expressed as a concentration in milligrams of the radicle per kilogram of water, by assuming the solution of one minimum dose in 4 kilograms of water. Life can be sustained for a few days by as little as one-quarter kilogram of water a day, and workers under the conditions of high temperature and low humidity in the desert [1] have been reported to drink as much as 7½ kilograms of water a day, but 4 kilograms is probably liberal under usual conditions. The minimum doses and the notes on their medicinal effects have been compiled from Cushny's Pharmacology,[1] Culbreth's Materia Medica,[2] the National Standard Dispensatory,[3] and Merck's Index.[4]

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[1] MacDougal, D. T., Botanical features of North American deserts: Pub. 99, Carnegie Institution, 1908, p. 109.

The classification and computation may be illustrated by the bromides. The bromide radicle is administered in the form of bromides of calcium, magnesium, strontium, sodium, potassium, and lithium, and as hydrobromic acid. These compounds exercise their therapeutic action chiefly by virtue of the bromide radicle, which acts as a sedative. Potassium bromide is a somewhat more powerful depressant than sodium bromide because of the additional depressing effect of the potassium ion. Hydrobromic acid in large doses may be an irritant. As the bromides of calcium and strontium are more slowly absorbed they are given in larger doses than the bromides of the alkalies, and their bromide content has therefore been omitted from the average in the following table.

Doses of certain bromides.

[Quantities expressed in grams.]

Compound.	Cushny.	Culbreth.	Dispensatory.	Index.	Mean minimum dose.	Equivalent of minimum dose as bromide (Br).
$CaBr_2$	2–4	0.6–2	1.3–4	0.6–2	1.12	[a] 0.90
$MgBr_2+6H_2O$				.6–1.3	.60	.33
$SrBr_2$	2–4	.6–2	4–12	.2–.6	1.70	[a] 1.10
NaBr	1–4	.6–8	.6–8	.3–4	.62	.48
KBr	1–4	.6–4	.3–4	1.3–4	.80	.53
LiBr	1–2	.6–2	.6–2	.6–2	.70	.64
NH_4Br	1–2			1–2	1.00	.82
HBr	.6–1.2			.18–.55	.39	.39
Average						.53

[a] Omitted from average.

The figures representing doses differ because they are estimates based largely on clinical experience; the larger divergences in the minimum doses are chiefly due to difference of opinion as to whether a certain quantity should be administered at one time or in several smaller portions. Consequently the largest differences in quantity do not invalidate the averages. Though more than one minimum dose a day of these and many other salts may be prescribed it has been consistently assumed that only one dose is taken. If the average quantity, 0.53 gram of bromide, were in 4 kilograms of water the concentration of the radicle would be 132 milligrams per kilogram. In other words, a person who had drunk 4 kilograms of water containing 132 parts per million by weight of the bromide radicle (Br) might exhibit the symptoms produced by bromides if the water did not also contain some other radicle antagonistic to the bromide; or, to state it in another way, 530 kilograms of water containing one part per million of bromide must be drunk before enough bromide to be equivalent to one small dose has been introduced into the system. If the computed quantity, 132, is rounded off to 100 milligrams per kilogram in order to allow for variation in estimates of doses the latter figure may be considered to represent the smallest amount of the bromide radicle that might produce the symptoms of the characteristic bromide reaction, and consequently to be the lowest concentration that might give a natural water medicinal qualities by virtue of its bromide content.

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[1] Cushny, A. R., A textbook of pharmacology, 3d ed., Philadelphia, 1903.
[2] Culbreth, D. M. R., Materia medica and pharmacology, 4th ed., Philadelphia, 1906.
[3] Compiled by Hare, Caspari and Rusby, 2d ed., Philadelphia, 1909.
[4] Published in 1907 by Merck & Co., New York.

The following table gives similar estimates for the radicles commonly occurring in natural waters in appreciable amount and for some of those occurring in very small quantities to which pharmacologic action is sometimes ascribed. Consistent effort has been made throughout the computations to have the concentrations finally expressed represent a minimum, below which therapeutic activity could not logically be attributed to the radicle in question, and every reasonable allowance has been made with that object in view.

Minimum medicinal doses of certain radicles and their equivalent concentration in 4 kilograms of water arranged in order of concentration.

Radicle.	Average minimum dose (grams).	Equivalent concentration (milligrams per kilogram).
Arsenite (AsO_2)	[a] 0.0002	0.2
Arsenate (AsO_4)		.3
Fluoride (F)	.002	.5
Barium (Ba)	.003	.7
Hydroxide (OH)	.013	3
Aluminum (Al)	.011	[b] 3
Iron (Fe)	.024	6
Lithium (Li)	.075	15
Ammonium (NH_4)	.078	20
Manganese (Mn)	.12	30
Metaborate (BO_2)	[c] .035	30
Pyroborate (B_4O_7)		30
Iodide (I)	.12	30
Calcium (Ca)	.2	50
Magnesium (Mg)	.2	50
Orthophosphate (PO_4)	.23	50
Carbonate (CO_3)	.281	70
Sulphite (SO_3)	.315	70
Thiosulphate (S_2O_3)	.300	70
Nitrate (NO_3)	.5	100
Bromide (Br)	.53	100
Sulphate (SO_4)	.6	150

[a] Equivalent as arsenic (As). [b] In acid solution. [c] Equivalent as boron (B).

THERAPEUTIC ACTION OF CERTAIN INORGANIC RADICLES.

The typical reactions that occur after ingestion of medicinal doses of some radicles found in natural waters are outlined in the following paragraphs, together with the data on which the preceding table is based. Two or three general factors influencing the size and effect of doses of medicine may first be mentioned. A drug may fail to cause its characteristic action if an antagonistic substance is present, and influence of that nature may be very important in such complex systems as natural waters. Solutions of the chlorides of calcium, sodium, and potassium interfere with each other under certain conditions, and this mutually antagonistic action may partly explain the tolerance of the human body for the unusually large quantities of inorganic matter in some drinking waters. Another interference that possibly may not be termed antagonism might occur when a water containing one radicle in sufficient concentration to be therapeutically active contains also much of another active radicle of different nature. Thus a water carrying 30 milligrams per kilogram of lithium and 3,000 milligrams per kilogram of the chloride radicle would have little value as a lithia water because of its strong salinity.

Acquired tolerance induced by prolonged use of a drug may lessen the susceptibility of the subject to some effects of it. This may explain why some persons who apparently are given diarrhea by change in drinking water soon recover without again changing the source of supply.

Small repeated doses of certain drugs finally induce symptoms that are more marked than those caused by a single small dose. Such cumulative effect may be observed in lead poisoning. Most of the ordinary constituents of natural waters are, however, subject to rapid elimination from the body, and therefore this factor is not effective.

Calcium is a normal and necessary constituent of the body, and if the supply of it in the food is insufficient the bony tissues especially suffer.[1] Though a deficiency is harmful, an excess is little to be feared under ordinary modes of administration according to Cushny,[2] for sufficient calcium to supply the needs of the tissues is absorbed, whether the element is ingested in solution or in solid form, and any excess is excreted by the intestine. An estimate of the minimum effective concentration of calcium in water is unsatisfactory because so little distinctive action can be assigned to this radicle. The smallest average dose of calcium in the form of carbonate is 0.30 gram; as the phosphate, 0.17 gram; and as the chloride, 0.14 gram; or an average of 0.2 gram, which corresponds to a concentration of 50 milligrams per kilogram of calcium in 4 kilograms of water. Very many supplies in the United States exceed this concentration and are used for drinking without any apparent harmful results. The concentration of calcium that can be tolerated in carbonate or sulphate waters used for drinking is at least three or four times as great as this amount. The idea has been advanced that very hard waters are detrimental to health, but experience with them in the United States has failed to substantiate such claim, though it must be admitted that experimental data are meager. Berg attempts to show by numerous statistics that people from the districts of Germany where the drinking water is hard have better teeth, larger chests, and superior physical development than in districts where the drinking water is poorer in mineral salts.[3] It would not be reasonable to consider that all waters exceeding 50 parts per million in content of calcium have therapeutic value by virtue of the calcium, but it is apparently safe to disregard the medicinal effect of calcium in waters of less concentration.

The sodium and chloride ions have very little specific action, their physiologic effect when they are swallowed being due to addition or withdrawal of fluid by osmosis. Sodium chloride in strength not affecting osmosis (normal, isotonic, or physiologic solution) is a favorite medium for use in the introduction of other substances into the blood by hypodermic injection. Joseph and Meltzer[1] have shown it to be one-ninth to one-nineteenth as toxic as the chlorides of potassium, calcium, and magnesium when injected into dogs, for which the fatal dose of sodium chloride was found to be 3.7 grams per kilogram of body weight, corresponding to nearly 280 grams of salt for a man of average weight. Solutions of sodium chloride are readily absorbed from the alimentary canal. Weak solutions (hypotonic) are absorbed more rapidly than pure water, which is not absorbed until it has acquired a certain content of salts by diffusion from the blood. Very strong solutions (hypertonic) must first be diluted by diffusion from the blood, and then afterwards the salt may be absorbed. An excellent discussion of the therapeutic effects of solutions containing sodium chloride is given by Cushny.[2]

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[1] Aron, H., and Sebauer, R., Investigation of the importance of calcium salts for the growing organism: Biochem. Zeitung, vol. 8, p. 1; Chem. Abstracts, vol. 2, 1908, p. 2117.

Goitein, S., The influence of varying amounts of calcium and magnesium on metabolism: Arch. ges. Physiol. (Pflüger) vol. 115, p. 118; Chem. Abstracts, vol. 1, 1907, p. 75.

[2] Cushny, A. R., A textbook of pharmacology, 3d ed., Philadelphia, 1903, p. 570.

[3] Berg, Ragner, The influence of the salts of drinking water upon the physical development: Biochem. Zeitung, vol. 24, p. 282; Chem. Abstracts, vol. 4, 1910, p. 1764; also, Berg, Ragner, and Röse, Carl The mechanism of the process by which the hardness of drinking water influences physical development: Biochem. Zeitung, vol. 27, p. 204; Chem. Abstracts, vol. 4, 1910, p. 3106.

The smallest dose of sodium bicarbonate contains about 0.14 gram of sodium, that of the sulphate 0.28 gram, of the chloride 0.24 gram, and of the carbonate 0.06 gram, corresponding, respectively, to concentrations in 4 kilograms of water of 35, 70, 60, and 15 milligrams per kilogram of sodium; these amounts, however, represent, not the activity of the sodium ion, but more especially that of the acidic ions with which the base is in equilibrium. It is interesting to note that the order of effectiveness of the salts given above corresponds to the order of tolerance of both animals and plants for these salts in alkali waters. So far as salt waters are concerned, it is evident that the problem is more one of concentration than of actual amount of the sodium and chloride ions ingested, and it might be concluded that a solution containing less than 500 milligrams per kilogram of sodium chloride would not interfere with normal osmosis.

Though potassium arrests the action of the heart when it is introduced into the blood,[3] it has practically no action on the heart when given by the stomach, according to Cushny,[4] because it is so rapidly excreted in the urine. The latter writer also states that much greater quantities of potassium are taken daily in the food of thousands of persons than are ever prescribed in medicine. On account of the apparent lack of action no estimate of concentration of potassium is included in the table. Salts of potassium in general are so easily dissolved and so readily absorbed that compounds with that base are widely used in the practice of medicine.

So little information is available concerning the therapeutic power of sulphides that a minimum effective concentration of the sulphide radicle is not estimated. Cushny states[5] that the ordinary alkaline sulphides are unimportant in themselves, as they are seldom used in therapeutics. He adds that hydrogen sulphide is irritating in the intestine and thus likely to induce laxative action. Sabbatani[6] found that a certain colloidal sulphur was changed into sulphate before absorption when it was fed to animals. Coleschi[7] concludes that the increased secretion of gastric juice obtained with mineral waters containing sodium sulphide, hydrogen sulphide, and iron is due to carbon dioxide in the water, as the same waters gas-free have no effect on gastric secretion. Researches by Desmoulières and Chatin indicate that sulphur waters increase the power of the blood to dissolve lbuminates of mercury and therefore increase the ability of the body to take care of ingested mercury compounds.[1]

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[1] Joseph, D. R., and Meltzer S. J., The relative toxicity of the chlorides of magnesium, calcium, potassium, and sodium: Proc. Soc. Exp. Biol. Med., vol. 5, p. 85; Chem. Abstracts, vol. 2, 1907, p. 2825.

[2] Op. cit., pp. 490–497.

[3] Busquet, H., and Pachon, V., The muscular mechanism of the cardio-inhibitory action of potassium: Compt. rend. Soc. biol., vol. 62, p. 785; Chem. Abstracts, vol. 1, 1907, p. 2139.

[4] Op. cit., p. 498.

[5] Op. cit., p. 577.

[3] Sabbatani, L., The pharmacological action of colloidal sulphur: Arch. intern. pharmacodyn., vol. 18, p. 373; Chem. Abstracts, vol. 3, 1909, p. 1413.

[7] Coleschi, L., The influence of waters containing sulphur and iron on the functions of the stomach: Arch. farm. spher., vol. 10, p. 120; Chem. Centralbl., 1911, I, p. 167; Chem. Abstracts, vol. 5, 1911, p. 2111.

Sulphates in moderately large doses are cathartic, and they are generally believed to exercise this property chiefly through salt action, hough Tyrode[2] concludes that purgation is caused by action of the salts on the neuro-muscular elements of the intestine and that osmotic action is not a necessary condition. Cushny[3] states that all compounds in which the sulphate radicle is found are less readily absorbed through the intestinal walls than the corresponding bromides and chlorides; consequently when sulphates are present in strong soluion, they are diluted by osmosis, thereby causing distention of the ntestine and increased peristalsis. Sodium and magnesium sulphates are the commonest sulphate cathartics. The fact that magnesium chloride, also slowly absorbed, is laxative indicates that the magnesium ion too has cathartic properties. This double effect explains why magnesium sulphate is more powerful than either sodium sulphate or magnesium chloride. Doses of many sulphates, trychnine sulphate, for example, are not laxative because the other ons administered at the same time are so much more powerful. Ferrous sulphate, one of the most astringent salts of iron in usual dose, is reported to cause purging in overdoses.[4] The bases most abundant in natural waters are calcium, magnesium, sodium, and potassium, and the doses of the sulphates of the last three have been used as a means of estimating the lowest concentration of the sulphate radicle that may be therapeutically active. The smallest dose ecommended by the various authorities is equivalent to about 0.6 gram SO_4. This amount evidently should be contained in a quantity of water that might be drunk within a comparatively short period, because otherwise the radicle would not be concentrated enough to cause perceptible reaction. Nevertheless, the minimum dose has been divided by four in order that this may be on the same basis as he other tabulated estimates—the equivalent of the smallest medicinal dose in one day's large consumption of drinking water. A kilogram of water containing 600 milligrams per kilogram of the sulphate adicle might exercise gentle laxative action. The maximum doses, to 30 times that concentration, would probably cause violent purgng. The statement in several treatises on mineral waters that calcium sulphate has no particular therapeutic action is probably a misinterpretation of the fact that this salt is not used as an internal medicine. Though it is only slightly soluble in pure water it is soluble o greater extent in solutions of alkaline chlorides, and there seems no good reason for doubting that the sulphate radicle in a gypsum water may exert salt action to cause purging.

More than half of the thirty-odd compounds of magnesium used as nternal medicines are administered chiefly for the effect of the acidic radicles, the magnesium serving as a convenient base. Nearly all of the other compounds of magnesium are cathartics, and they seem to produce the laxative effect chiefly by the salt action that takes place because the magnesium ion is slowly absorbed through the walls of the stomach and intestine. The slow absorption explains the apparent harmlessness of magnesium sulphate given by the mouth; Meltzer and others have shown that the magnesium ion is strongly poisonous when it is introduced into the blood.[1] A large proportion of the magnesium administered by the mouth may be excreted unabsorbed by the intestine, and according to Cushny[2] that which is absorbed is probably excreted rapidly by the kidneys. The medicinal compounds of magnesium that may be considered in connection with natural waters are the sulphate, the chloride, the bisulphate, and possibly the "carbonate" and the oxide. The last two are very insoluble and become active only when they are dissolved; part of them is changed to magnesium chloride in the stomach and part may be dissolved by the carbon dioxide in the intestine.[2]

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[1] Desmoulières, A., and Chatin, A., Researches on the action of sulphur waters in the mercurial treatment: ompt. Rend., vol. 144, p. 1177, Chem. Abstracts, vol. 1, 1907, p. 2156.

[2] Tyrode, M., Action of some purgative salts: Arch. intern. pharmacodyn., vol. 22, pp. 205; Chem. bstracts, vol. 5, 1911, p. 113.

[3] Op. cit., p. 535.

[4] National Standard Dispensatory, p. 662.

Magnesium silicate, an astringent, may be disregarded, because the presence of a silicate radicle in water is doubtful and magnesian waters are known to be laxative. The oxide (MgO) and the "carbonate" (approximately $(MgCO_3)_4 . Mg(OH)_2 + 5H_2O$ [U. S. P.]) are given in small doses as antacids because of their alkaline reaction and in larger doses as laxatives. The minimum laxative doses of them average, respectively, 1.2 grams and 0.5 gram in equivalent of magnesium, but these are not fair estimates because the compounds are so slowly dissolved. The chloride ($MgCl_2 + 6H_2O$) is less powerful than the sulphate ($MgSO_4 + 7H_2O$), the minimum dose of which contains an equivalent of 0.2 gram of magnesium. In these estimates, therefore, it is safe to assume that water containing less than 50 milligrams per kilogram of magnesium would not have laxative action by virtue of its magnesium. The maximum dose of magnesium sulphate is equivalent to 4 kilograms of water containing nearly 750 milligrams per kilogram of magnesium, or, roughly, a quart of water containing about 2,500 parts per million of magnesium.

The hydroxides exercise their pharmacologic action principally by neutralizing acids and dissolving proteids and partly by saponifying fats. They are administered as aluminum, calcium, magnesium, sodium, or potassium hydrate, but as the latter two are possibly more distinctive in their action and are given in smaller doses because they are more rapidly absorbed, they alone have been included in the computations.

The carbonates and bicarbonates, similar to the hydroxides in their action, are used chiefly as antacids. The computed concentration of these based on the doses of sodium and potassium carbonates and bicarbonates and calcium carbonate has been uniformly reduced to the carbonate equivalent (CO_3). Magnesium ''carbonate,'' so called (approximately $(MgCO_3)_4.Mg(OH)_2+5H_2O$) is antacid or cathartic in different doses, is very slowly absorbed, and has been omitted. As carbonates react with the hydrochloric acid in the stomach, there is evolved some carbonate dioxide, which in sufficient quantity has a slight irritating action that may cause increased appetite. According to Cushny[1] this readily absorbed gas is excreted by the lungs and has no effect on the organism. Excessive alkalinity of water ingested would obviously cause digestive disturbances by reducing the acidity of the gastric juice. Though it is not at all uncommon for natural waters in regions of limestone to have an alkalinity exceeding 70 parts per million of carbonates, yet the likelihood of their causing stomach trouble is little to be apprehended when it is realized that gastric juice contains normally 2,000 parts per million of hydrochloric acid[2] and that a single dose of the carbonates of sodium, potassium, calcium, or magnesium may contain 800 milligrams of the carbonate radicle, while the maximum daily quantity of sodium carbonate prescribed may contain as much as 3 grams of the acid radicle.

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[1] Meltzer, S. J., and Auer, John, The toxicity of intravenous injections of magnesium salts: Am. Jour. Physiology, vol. 15, p. 387; The relation of the salts of magnesium to the peristalsis of the gastrointestinal canal: Idem, vol. 17, p. 313.

Meltzer, S. J., Inhibitory and anesthetic properties of magnesium salts: Med. Rec., Dec. 16, 1906; The toxicity of magnesium nitrate when given by the mouth: Proc. Soc. Exp. Biol. Med., June 22, 1907; The influence of diuresis upon the toxic dose of magnesium salts: Idem.

Joseph, D. R., and Meltzer, S. J., The relative toxicity of the chlorides of magnesium, calcium, potassium, and sodium: Proc. Soc. Exp. Biol. Med., vol. 5, p. 85.

Jackson, S. A., and Jackson, D. E., The action of magnesium sulphate upon the heart and the antagonistic action of some other drugs: Am. Jour. Physiology, vol. 19, p. 5.

Stiles, P. G., On magnesium and contractile tissues: Proc. Soc. Exp. Biol. Med., Apr. 17, 1907.

[2] Cushny, A. R., op. cit., p. 540.

The alkaline and alkaline-earth compounds of iodine and fluorine, like those of bromine, owe their action chiefly to the acidic ions. The iodide radicle is administered as iodide of iron, manganese, calcium, strontium, magnesium, ammonium, sodium, or potassium, or as hydriodic acid, but usually in one of the last three forms. It is classed as an alterative, having profound influence on nutrition of the tissues. The fluoride radicle, little used internally, is sometimes given in the form of sodium fluoride. It is a powerful irritant.

The compounds of boron are mainly antiseptic; some that have been used medicinally are the pyroborates of calcium and sodium, orthoboric acid, and the ''borate'' of magnesium ($Mg(BO)_2.2Mg(OH)_2+7H_2O$?). Analysts of mineral waters usually express all the boron as one or the other of the two common radicles without differentiation.

Arsenic has physiologic action when the arsenite or the arsenate ion is formed. This powerful poison is given internally as arsenic trioxide, ferrous arsenate, ferric arsenite, sodium arsenite, potassium arsenate and arsenite, and arsenic chloride, bromide, and iodide in minimum doses ranging from 0.25 to 1.25 milligrams in their content of arsenic. The maximum daily consumption is limited to about 7.6 milligrams of arsenic, the quantity that would be contained in 38 kilograms of water that held 0.2 milligram per kilogram of arsenic.

Though lithium may be prescribed in the form of at least 30 different salts only a few of them may be represented in natural waters, and of these few the arsenate, bromide, and iodide should be omitted in considering the therapeutic power of the base because their acidic ions exercise the distinctive medicinal action. This leaves the carbonate, chloride, nitrate, orthophosphate, and sulphate from which to compute the minimum effective concentration of the lithium radicle. The computed figure, 19 milligrams, has been further rounded off to 15 milligrams per kilogram to allow for possible divergences in estimates of the proper dose. Lithium has a specific gravity so low that the difference between its weight and that of its salts is very great. One part of lithium is equivalent to 5.3 parts of lithium carbonate, 6.1 parts of lithium chloride, 7.9 of the sulphate, and 9.7 of the bicarbonate.

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[1] Op. cit., p. 584.

[2] Halliburton, W. D., Kirk's handbook of physiology, 17th ed., Philadelphia, 1902, p. 481.

The minimum concentration of the orthophosphate radicle is computed from the doses of the orthophosphates of calcium, sodium, potassium, and ammonium and of orthophosphoric acid.

Manganese has been prescribed for anemic and chlorotic persons, the compounds used for its administration being the carbonate, sulphate, monoxide, and dioxide.

Estimates on barium are rather unsatisfactory because of the limited use in medicine of compounds containing that radicle. It is the most poisonous of the three common alkaline earths, but it is absorbed very slowly, from the alimentary canal.[1] The nitrate and the chloride are given internally in treatment of certain arterial troubles, and the sulphide is sometimes used. The smallest dose [2] is about 3 milligrams, and the largest quantity generally considered safe to ingest in 24 hours is 300 milligrams. Therefore, water containing 0.7 milligram per kilogram of barium might be classed as medicinal by virtue of its barium content, and one containing 10 milligrams would be likely to cause strong barium reactions if other radicles in the water were not antagonistic.

The nitrates of sodium and potassium have marked diuretic and diaphoretic action, and the estimate of the minimum concentration of the nitrate radicle has been based on the doses of them.

The distinctive reactions following the administration of the ammonium radicle by the mouth are well shown by the chloride, hydrate, and "carbonate" compounds, which are all stimulants and expectorants. These are rapidly absorbed from the alimentary canal though the sulphate fails to penetrate so well as the others, and is, therefore, slightly cathartic. Ammonium compounds are changed to urea in the body and are excreted mostly in the urine.

The sulphites and the bisulphites are fairly strong antiseptics when taken into the stomach, because they withdraw oxygen from organic matter to become sulphates, in which form they are absorbed and eliminated. Therefore large doses of them might be expected to have laxative action. They are probably decomposed by the acid of the gastric juice. The doses of the sulphites and bisulphites of sodium potassium, and magnesium have been used for computing the concentration of these radicles and the result has been expressed as the sulphite radicle (SO_3).

The thiosulphates of calcium, magnesium, and sodium, also reported to be antiseptics, have been grouped to estimate the power of the thiosulphate radicle. The less strongly oxidized radicles containing sulphur are reported only in "sulphur" waters, and distinction among them is unsatisfactory because of the instability of these radicles; but this fortunately makes little difference from a therapeutic standpoint, as sulphites, bisulphites, and thiosulphates are so nearly alike in action and power.

The medicinal salts of iron most likely to be represented in natural waters are ferric chloride, ferric sulphate, and ferrous carbonate Ferric subsulphate and ferrous ammonium sulphate also may be included. Though iron in the free state and as the "subcarbonate"

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[1] Cushny, A. R., op. cit., p. 576.

[2] National Standard Dispensatory.

(mostly $Fe_2O_3.Fe(OH)_2$ or $Fe_2O_2(OH)_2$) are given, they are so slowly absorbed that they may be omitted, together with the numerous compounds of iron whose action is complicated by other radicles. Compounds of iron are essentially astringent and tonic, and they are used for anemic, debilitated, and similar conditions.

Aluminum hydrate is a mild astringent antacid; the commonest salt of aluminum, the sulphate, very seldom administered internally, is strongly astringent; the chloride is said to be used sometimes. Aluminum is apparently much more active in acid solution where its ionic activity is great than in alkaline solution where there may be some question as to whether it is in true or in colloidal solution.

TOLERANCE FOR MINERAL MATTER IN DRINKING WATER.

Though the lower waters are in mineral content the more acceptable they are as sources of domestic supply, the amount of dissolved substances that can be tolerated by the human organism is much greater than is ordinarily believed. No application of water is affected more strongly by local conditions than its use as a beverage. Finding most palatable the supplies with least taste, all animals select the sources that are lowest in solids and avoid those that are highest, but the same animals, when they are transported to districts of poor water, accustom themselves to mineral content far greater than that in the poorer waters they before would not touch.

Mac Dougal[1] reports that the experience of the field expeditions from the desert laboratory of the Carnegie Institution demonstrates that saline or alkaline water containing as much as 2,500 milligrams per kilogram of dissolved salts may be used for periods of many days without serious discomfort, but that if the proportion be increased to about 3,300 grams only hardened travelers may use the supply. He considers water containing as much as 5,000 milligrams per kilogram inimical to health and comfort, though it might suffice as a drinking supply for a few hours or might save the life of a person who had been wholly without water.

The analytical data in the accompanying table indicate to some extent the general limits in the relation between mineralization and potability and the relatively great quantities of mineral matter that can be in supplies used for drinking.

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[1] Mac Dougal, D. T., Botanical features of North American deserts: Pub. 99, Carnegie Institution, 1908, p. 109.

Mineral matter in certain waters.

[Milligrams per liter.]

No.	Carbonate radicle (CO_3).	Sulphate radicle (SO_4).	Chlorine (Cl.).	Total hardness as $CaCO_3$.	Total solids.	Calcium and magnesium (Ca+Mg).	Sodium and potassium (Na+K).	Character of water.
1	43	Tr.	4,310	2,800	7,489	966	1,550	Na-Cl.
2	360	1,560	1,300	....	5,000	....	....	Do.
3	75	5	1,740	910	3,600	300	830	Do.
4	46	328	1,520	506	3,600	170	1,030	Do.
5	54	390	1,060	490	2,800	160	750	Do.
6	200	5	279	31	872	11	320	Do.
7	110	2,300	800	....	4,900	....	....	Na-SO_4.
8	100	1,810	160	1,130	3,200	380	580	Do.
9	362	1,640	460	1,760	4,100	150	600	Do.
10	97	800	150	560	1,700	190	320	Do.
11	73	430	75	83	940	25	300	Do.
12	410	620	500	....	2,470	....	....	Na-CO_3.
13	963	Tr.	492	660	2,452	191	750	Do.
14	208	Tr.	135	47	750	15	240	Do.
15	100	Tr.	64	71	350	24	86	Do.
16	75	1,680	145	1,280	2,900	400	400	Ca-SO_4.
17	72	1,380	150	1,320	2,500	440	220	Do.
18	60	1,380	135	1,100	2,400	370	305	Do.
19	74	895	85	720	1,700	228	208	Do.

The figures represent approximate analyses of certain water tested mostly by the writer in the central valley of California. Th data, though approximate, are sufficiently accurate to indicate how great may be the concentration of certain kinds of water that can b used for drinking. The analyses are grouped according to the essential characteristics of the waters, and they are arranged by groups i descending order of their strength.

The first group comprises sodium chloride waters; that is, water in which alkalies and chlorides predominate. Analysis No. 1 represents essentially a solution of the chlorides of calcium, magnesium sodium, and potassium with little else. It is so salty that it i nauseating. The next water has been used by the owner's famil several years for all domestic purposes, but newcomers object to i and consider it disagreeable to drink. The water represented by No 3 was formerly used as a source of domestic supply, but it has bee abandoned. Though supplies Nos. 4 and 5 taste disagreeably salt to persons not accustomed to them they are regularly used for cooking, drinking, and washing. Two gallons of the former water contain about as much common salt as a pound of uncooked ham. No 6 is lower in chlorides but higher in carbonates. It contains muc gas and would be distasteful for that reason; otherwise, howeve it differs from No. 14 only in being somewhat higher in chlorides an alkalies.

Still more strongly mineralized waters of the alkaline-sulphat type are drunk. The first, corresponding to No. 7, was used whe necessary, but the domestic supply was hauled several miles. Th water represented by analysis No. 8 has a distinct taste, and drinkin a quart of it would be equivalent to taking somewhat less than a ordinary dose of Glauber's salt, but it has been used for all domesti purposes for several years. The water corresponding to No. 9 wa used in a cook wagon and for watering stock nearly a year, but it wa considered alkali water and was abandoned when better water coul be obtained. The alkaline carbonates as well as the sulphates ar notably high in this water. The waters corresponding to both Nos. 10 and 11 are used for all domestic purposes, though they have a distinct taste. The former is one of a battery of wells that have been the exclusive supply of a family for three years, and the latter supplies a small city. The concentration of the sulphate radicle in these two waters is three to five times the minimum concentration that has been tabulated for sulphates.

The examples in the next group indicate that less alkaline carbonates can be tolerated. The first of the group, No. 12, shows a water also high in chlorides, but not excessive in sulphates. A party of men accustomed to alkali was so badly afflicted with diarrhea after drinking this water that work had to be stopped until another supply could be obtained. No. 13 shows nearly double the amount of carbonates, but no sulphates. This water supplies a trough for stock, but it is evidently repellent to cattle, and common report in the neighborhood is to the effect that water from wells of the same depth "kills hogs," a term that seems to express the acme of undesirability. The mixture of alkaline carbonates and chlorides, with the former predominating, indicated by No. 14, has been used many years. It is much lower in carbonates than the preceding two. The water listed under No. 15 is a city supply and is drunk both by the inhabitants and by visitors without harmful effect.

Although the next four are designated calcium sulphate waters, the alkalies in them also are high and, furthermore, application of the term calcium necessarily implies the presence of magnesium in amounts ranging from 10 to 40 per cent of the total calcium and magnesium given in the seventh column of the table. The water corresponding to No. 16 can not be used for cooking, and rangers object to it so strongly that the drinking supply is obtained 8 miles away from the well reported by No. 17, which carries 300 parts less of sulphates and about one-half as much sodium and potassium. No. 18, which is similar to No. 17, has been used for cooking and drinking by one man more than 10 years. These three waters tasted unpleasantly strong to the writer and seemed to increase thirst instead of quenching it, but nevertheless they are drinkable and long continued use of the last two is without apparent effect. Although No. 19 is lower in sulphates that the preceding ones of this group it is still strongly mineralized; it is used for all purposes in a hotel.

The chief effect of drinking waters too high in mineral content usually is diarrhea. Many persons at first afflicted with this trouble become accustomed to the new supply and acquire what may be termed immunity. Whether such persons are later afflicted with other disorders due to continued use is not known. It would appear from the data in the table and the comments on it that alkaline carbonates are most injurious and alkaline sulphates least injurious, and that alkaline chlorides occupy an intermediate position. This arrangement corresponds to the order of the same substances in reference to their toxic effect on plants.

The most striking feature of the preceding table is the amount of mineral matter in most of the waters. Drinking waters exceeding 300 parts per million of carbonates, 1,500 parts of chlorides, or 2,000 parts of sulphates apparently are unhealthful to most people. These limits greatly exceed the concentration at which the substances in solution are clearly perceptible to the taste of the ordinary individual.

CONCLUSION.

The minimum medicinal doses of certain inorganic radicles that may be present in natural waters have been computed, and the general physiologic reactions following their introduction into the alimentary canal have been noted. These minimum doses have been expressed as equivalent concentrations in a day's supply of 4 kilograms of drinking water. The strengths thus obtained are proposed as standards for differentiating between "medicinal" and common waters, the assumption being that water by means of which one medicinal dose of a physiologically active radicle could not be administered in one day would not have therapeutic value by virtue of its mineral content. This does not necessarily imply, however, that use of such water may not be beneficial, for the improvement in health following the ingestion of hygienically pure water under proper regimen of diet, exercise, and similar factors is thoroughly recognized. On the other hand, supplies exceeding the minimum concentrations that have been tabulated may not necessarily possess special medicinal value, as every reasonable allowance tending to lower the standards has been made.

Some natural waters have therapeutic action that may be attributed to the inorganic substances in solution. Many other waters, however, owe what curative effect they may have to their character as fairly pure waters, free from organic contamination and from deleterious mineral constitutents.

The amount of inorganic matter that may be present in drinking waters without having appreciable physiologic effect is comparatively great.

MONAZITE AND ZIRCON.

By Douglas B. Sterrett.

INTRODUCTION.

Monazite and zircon are minerals containing rare-earth metals that become incandescent when heated and that are therefore valuable for use in certain forms of gas and electric lights. Monazite is the principal source of thorium nitrate, which is used in incandescent gas light mantles of the Welsbach type. Zirconium oxide, obtained from zircon, is used, together with yttria and other rare oxides, in the glower of the Nernst electric light. Monazite is a phosphate of cerium, lanthanum, and other rare metals containing a variable percentage of thoria. The thoria content of monazite used for commercial purposes ranges from 3 to 9 per cent. Minerals other than monazite have been used as a source of thorium nitrate, but the quantities available have been small. Zircon is a silicate of zirconium containing 67.2 per cent of zirconia (zirconium oxide).

The world's supply of monazite has come from Brazil and the United States, the production of Brazil being many times the greater. The monazite mined in the United States has come entirely from North Carolina and South Carolina. Deposits of monazite have been found in other States, and some of those in Idaho have been mined along with gold, but none of the monazite obtained in those States has been shipped for manufacture. Commercial monazite occurs in the form of sand and is mined from placer deposits. The deposits in the Carolinas lie in the gravels and bottom lands along the streams of a part of the Piedmont Plateau. The placers are associated with Archean gneisses and schists that are cut by granite and pegmatite. The Brazilian monazite sand comes from beach deposits on the coast, where it has been naturally concentrated by wave action, and from placer deposits in the river valleys in the interior.

Zircon occurs at numerous localities in the United States. In the form of sand it is associated with monazite in many placers. The commercial supply of zircon has been obtained from deposits containing crystals of larger size, measuring several millimeters long or across. Such deposits have been found at several places in North Carolina, South Carolina, and Oklahoma.

PRODUCTION.

Practically no monazite was produced in the United States in 1911. A total of 13,132 pounds of crude sand was reported as mined in North Carolina and South Carolina, but no shipments were made to the manufacturers. It is estimated that this crude sand would yield about 3,820 pounds of refined sand containing nearly 95 per cent of monazite.

During the last two years the monazite industry of the United States has practically ceased to exist. In 1909 the production was about normal and amounted to 541,931 pounds of refined sand, valued at \$65,032; in 1910 the production fell to 99,301 pounds, valued at \$12,006—a decrease in quantity of nearly 82 per cent. In 1911 no domestic monazite was shipped for manufacture and the small quantity mined was obtained from a few sluice boxes run chiefly to satisfy the terms of leases for certain deposits.

The following table gives the production and value of monazite from 1893 to 1902, inclusive; of monazite and zircon in 1903; of monazite, zircon, gadolinite, and columbite in 1904; of monazite, zircon, and columbite in 1905; of monazite and zircon in 1906 and 1907; and of monazite in 1908, 1909, 1910, and 1911:

Production, in pounds, of monazite in the United States, 1893–1910.

Year.	Quantity.	Value.	Year.	Quantity.	Value.
1893	130,000	\$7,600	1903	[a] 865,000	\$65,200
1894	546,855	36,193	1904	[b] 745,999	85,038
1895	1,573,000	137,150	1905	[c] 1,352,418	163,908
1896	30,000	1,500	1906	[d] 847,275	152,560
1897	44,000	1,980	1907	[e] 548,152	65,800
1898	250,776	13,542	1908	422,646	50,718
1899	350,000	20,000	1909	541,931	65,032
1900	908,000	48,805	1910	99,301	12,006
1901	748,736	59,262	1911	....	....
1902	802,000	64,160			

[a] Including 3,000 pounds of zircon, valued at \$570.

[b] Including the small production of zircon, gadinolite, and columbite.

[c] Including a small quantity of zircon and columbite.

[d] Including 1,100 pounds of zircon, valued at \$248.

[e] Including 204 pounds of zircon, valued at \$46.

The decline of monazite mining has worked a hardship on those sections of the Carolinas from which monazite was obtained. Although the value of the output of monazite was small in comparison with that of many other minerals of the United States, the money was so distributed as to be of great benefit to essentially agricultural communities. Many of the monazite mines of the Carolinas are owned by farmers and have either been worked by them or leased. Leases have been made both to large mining companies and to individuals. The large companies have generally sublet their leases on a royalty basis, but some have operated their own deposits. Thus a large part of the actual mining of the monazite has been done by the farmers of the monazite region. Some devoted the greater part of their time to mining and others mined only when their crops required little attention. The returns from monazite mining have been the chief support of some farmers and have tided many others over years of bad crops.

The production of zircon in 1911 amounted to 3,208 pounds, valued at \$802. The output came from Henderson County, N. C., where mines were operated by W. E. Hidden, of Newark, N. J., and M. C. and C. F. Toms, of Hendersonville, N. C. Mr. Hidden worked the old Freeman mine, about 2 miles west of Zirconia, and the Messrs. Toms worked the Jones mine, near Zirconia. Both deposits have been known for many years, but the Freeman mine had not been operated for 24 years and the Jones mine has been worked only intermittently.

Mr. Hidden reports considerable preparation for a larger production of zircon and a careful test for auerlite at the Freeman mine. The mine has been cleaned of accumulated débris and vegetation, and a new ditch about 6,000 feet long with trestles and flumes has been constructed to bring water for washing. The zircon crystals are obtained and concentrated by washing the decomposed pegmatite matrix. About 1 kilogram of auerlite was obtained from the zircon concentrates during the brief operations of 1911. Mr. Hidden hopes to find a new commercial source of thorium oxide in the mineral auerlite. This mineral has been found only in the zircon deposits of Henderson County, N. C. It contains approximately 70 per cent of thorium oxide and has been considered a silico-phosphate of thorium containing water.[1] Mr. Hidden expects the auerlite concentrates to yield more than 50 per cent of thoria, in which case this mineral would prove a valuable ore of that oxide if found in quantity.

IMPORTS.

According to the Bureau of Statistics of the Department of Commerce and Labor, 705,149 pounds of monazite and thorite, valued at $60,542, were imported for consumption into the United States in 1911, as compared with 458,788 pounds, valued at $48,199, in 1910. The imports of thorium nitrate in 1911 amounted to 121,111 pounds, valued at $238,841. The imports of thorium nitrate during the years 1904 to 1911 are shown in the following table:

Imports for consumption of thorium nitrate into United States, 1904–1911, in pounds.

Year.	Quantity.	Value.	Year.	Quantity.	Value.
1904	58,655	$249,904	1908	65,289	$173,239
1905	52,378	269,504	1909	127,833	236,057
1906	40,090	139,929	1910	124,808	219,615
1907	51,441	152,666	1911	121,111	238,841

The average price of thorium nitrate per pound in foreign markets, as deduced from this table, was $1.97 in 1911, against $1.76 in 1910, and $1.85 in 1909.

The imports of thorium nitrate in 1911 were but little less than those of the preceding two years, but the imports of monazite and thorite exceeded those of 1910 by 246,361 pounds in quantity and $12,343 in value. There were no imports of monazite for several years prior to 1909, and the domestic production supplied the demands of the manufacturers of thorium nitrate in the United States. Beginning with 1909 monazite has been imported in increasing quantities and the domestic production has declined. In 1911 the demands of manufacturers of thorium nitrate in the United States were supplied entirely by imported monazite, no domestic sand being used. It is not probable that the monazite deposits of the Carolinas will be operated extensively again in competition with imported sand under the present rate of duty.

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TALC AND SOAPSTONE.

By J. S. Diller.

PRODUCTION.

With the exception of a small production in California the entire output of talc and soapstone in the United States is limited to a comparatively narrow belt of ancient crystalline rocks running through the Atlantic States from Massachusetts and Vermont to Georgia. The producing States are Georgia, Maryland, Massachusetts, New Jersey, New York, North Carolina, Pennsylvania, Rhode Island, Vermont, and Virginia.

The total production for 1911 was 143,551 tons, valued at $1,646,018, or, compared with the output for 1910, a decrease of 4.8 per cent in quantity but an increase of 3.4 per cent in value, owing, apparently, to the sale of a larger proportion of the output in manufactured form.

The relative rank of the producing States, with percentage of increase and decrease in quantity and value, is shown in the accompanying table:

Relative rank of States in output of talc and soapstone, with percentage of increase (+) and decrease (−) in quantity and value in 1911 as compared with 1910.

Rank.	State.	Quantity.	Value.
		Per cent.	*Per cent.*
1	New York	−13	−16
2	Vermont	+14	+46
3	Virginia	+ 3.2	+29
4	Pennsylvania	− 4	− 9
5	Massachusetts	+ 2	−29
6	North Carolina	− 9	−18
7	Georgia	− 1	−19
8	New Jersey	−36	−33
9	Rhode Island	−28	−48
10	Maryland	−54	−47
11	California	−47.8	−45.5
	Total for the United States	− 4.8	+ 3.4

More than 43 per cent of the total output of the United States came from New York, the total production of which State, with one new producer and a former producer idle, declined about 13 per cent in quantity and 16 per cent in value. The variation in the production of the different States, although in part owing to irregularities in the available deposits which are large, depends also upon the market demand, and the declines were generally ascribed to dull business. The stock reported on hand was larger than in 1910.

The supply of best grades of talc in the United States, such as are used for toilet powders, electric insulators, gas tips, and the like, is not nearly equal to the demand. Such grades are imported chiefly from Italy and France.

The following table illustrates the development of the talc and soapstone industry in the United States since 1880:

Production of talc and soapstone in the United States, 1880–1911, in short tons.

Years.	Quantity.	Value.	Years.	Quantity.	Value.
1880–1900	969,928	$11,224,652	1906	120,644	$1,431,556
1901	97,843	908,488	1907	139,810	1,531,047
1902	97,954	1,140,507	1908	117,354	1,401,222
1903	86,901	840,060	1909	130,338	1,221,959
1904	91,189	940,731	1910	150,716	1,592,393
1905	96,634	1,082,062	1911	143,551	1,646,018

Talc and soapstone are usually marketed either as rough or crude from the mine, as sawed into slabs, as manufactured articles, or as ground talc. In the following table the quantities produced and the value and average price per ton of each class are given for the years 1908–1911:

Production of talc and soapstone in the United States according to varieties, 1908–1911, in short tons.

Condition in which marketed.	Quantity.	Value.	Average price per ton.	Quantity.	Value.	Average price per ton.
	1908			1909		
Rough	3,013	$7,819	$2.60	27,412	$79,499	$2.90
Sawed into slabs	3,406	71,048	20.86	2,893	54,009	18.67
Manufactured articles [a]	16,336	442,624	27.10	22,646	502,447	22.19
Ground [b]	94,599	879,731	9.20	77,387	586,004	7.57
Total [c]	117,354	1,401,222	11.94	130,338	1,221,959	9.38
	1910			1911		
Rough	15,425	$56,872	$3.69	13,304	$56,387	$4.24
Sawed into slabs	9,352	78,042	8.34	3,504	70,641	20.16
Manufactured articles [a]	22,363	503,391	22.51	23,179	660,219	28.48
Ground [b]	103,576	954,088	9.21	103,564	858,771	8.28
Total [c]	150,716	1,592,393	10.57	143,551	1,646,018	11.47

[a] Includes bath and laundry tubs; fire brick for stoves, heaters, etc.; hearthstones, mantels, sinks, griddles, slate pencils, gas tips, burner blanks, crayons, and numerous other articles for everyday use.

[b] For foundry facings, paper making, lubricators for dressing skins and leather, etc.

[c] Exclusive of the quantity used for pigment.

In 1911 more than 9 per cent of the material was sold as crude from the mine, nearly 3 per cent as sawed into slabs, 16 per cent as manufactured, and 72 per cent as ground. It is remarkable that, notwithstanding the general decline, there was an increase of 3.6 per cent in the sales of manufactured articles, and this accounts for the fact that in Vermont and Virginia, the only States producing soapstone, the increase in value was much greater than the increase in quantity.

In the following table those producing States containing more than two mines are given in alphabetic order; the remaining States are given together under "Other States," to avoid disclosing the production of individual mines. New York ranks first in quantity, though second in value, and produces ground talc only. Virginia ranks third in quantity, but first in value, on account of its large production of soapstone. Vermont ranks second in quantity, but third in value, being excelled in the latter respect by both Virginia and New York.

In Vermont 6 per cent of the output was sold crude, 6 per cent was manufactured, and 88 per cent was ground; in Virginia 6 per cent was sold crude, 13 per cent was in slabs, 78 per cent was manufactured, and 3 per cent was ground. In both States soapstone only was used in the manufactured products.

Production of talc and soapstone, 1909–1911, by States, in short tons.

States.	1909		1910		1911	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Massachusetts	9,057	$48,729	7,475	$52,204	7,642	$36,883
New Jersey and Pennsylvania	13,900	61,967	13,192	62,833	12,131	54,319
New York	48,536	359,957	71,710	728,180	62,030	613,286
North Carolina	5,956	77,983	3,887	69,805	3,548	57,101
Vermont	23,626	120,329	25,975	136,674	29,488	200,015
Virginia	26,511	523,942	25,908	510,781	26,759	660,926
Other States[a]	2,752	29,052	2,569	31,916	1,953	23,488
Total	130,338	1,221,959	150,716	1,592,393	143,551	1,646,018

[a] California, Georgia, Maryland, and Rhode Island.

IMPORTS.

The total imports of talc for consumption in 1911 were 7,113 short tons, valued at $88,050, a decline of nearly 15 per cent in quantity and of 17.3 per cent in value, as compared with the corresponding imports for 1910.

Talc imported for consumption into the United States, 1902–1911, in short tons.

Years.	Quantity.	Value.	Average price per ton.	Years.	Quantity.	Value.	Average price per ton.
1902	2,859	$35,366	$12.36	1907	10,060	$126,391	$12.56
1903	1,791	19,677	10.99	1908	7,429	97,096	13.07
1904	3,268	36,370	11.13	1909	4,417	56,287	12.74
1905	4,000	48,225	12.05	1910	8,378	106,460	12.71
1906	5,643	67,818	12.02	1911	7,113	88,050	12.38

Nearly one-half of the imported talc came from Italy and about one-third from France. Canada furnished 816 tons—the total Canadian production being 7,300 tons—and Germany, Austria-Hungary, England, and Belgium furnished smaller quantities. The total average value per ton was $12.38.

TALC INDUSTRY BY STATES.

GEORGIA.

The production of talc in Georgia in 1911 declined 1 per cent in quantity and 19 per cent in value as compared with that of 1910.

Chatsworth, with two producing companies, is the center of the talc industry in Georgia. The Georgia Talc Co. and the Cohutta Talc Co. have their mills located on the Louisville & Nashville Railroad in Chatsworth, but the mines are in the schist belt a few miles southeast. The best grade of material is sawed for pencils and other objects, but the lower grades are ground. It is reported that the Fort Mountain Talc Co. and also the Piedmont Talc Co. are about to begin producing in that region.

MASSACHUSETTS.

In Massachusetts the production increased 2 per cent in quantity and decreased 29 per cent in value as compared with that of 1910.

The Massachusetts Talc Co. is the largest of the three producers in the State. Its plant at Zoar was burned March 25 and rebuilt July 15, 1911. The total output of the company was thus reduced, although with the increased capacity of the new plant, the output is being advanced.

The mill at Zoar is on the Boston & Maine Railroad and Deerfield River, but the mine is among the hills, 4 miles to the north in the town of Rowe, not far from the mine and mill of the Foliated Talc Co., which also reports an increasing annual production. The Northampton Talc Co. reports a small production near Hoosac Tunnel.

The talc belt of New England traverses more or less continuously the entire length of Vermont and crosses the western portion of Massachusetts, affording a number of prospects in Berkshire and Franklin counties, but the only productive localities in Massachusetts during 1911 were in the town of Rowe, near Zoar.

The management of the Massachusetts Talc Co. is operating not only its own plant, but also the plant of the Vermont Talc & Soapstone Co., in the same belt, 40 miles farther northeast in the town of Windham, Vt.

NEW JERSEY.

In New Jersey the output declined about 36 per cent in quantity and 33 per cent in value from that of 1910. The product was almost wholly ground, though a small portion was sold in blocks. The Lizzie Clay & Pulp Co. was the only producer; its quarry is on the Delaware, Lackawanna & Western Railroad by Delaware River, 2 miles north of Phillipsburg. The talc schist is associated with rocks generally granular crystalline. These rocks contain a variety of minerals, among which carbonate of lime and serpentine are most common, and they render the rock useful as ornamental marble.

NEW YORK.

Notwithstanding a decline of 9,680 tons, or 13 per cent, as compared with the production in 1910, New York maintained in 1911 its preeminence among the talc-producing States by an output of 62,030 short tons.

The importance of New York in the talc industry is illustrated by the following table, showing the annual quantity and value of its production since 1901 as compared with that of all the other States combined:

Production and value of the talc and soapstone of New York, 1880–1911, as compared with that of all the other States combined, in short tons.

Years.	New York.			All other States.	
	Quantity.	Value.	Price per ton.	Quantity.	Value.
1880–1900	629,925	$5,933,501	$9.42	340,003	$5,291,151
1901	69,200	483,600	6.99	28,643	424,888
1902	71,100	615,350	8.65	26,854	525,157
1903	60,230	421,600	7.00	26,671	418,460
1904	64,005	507,400	7.93	27,184	433,331
1905	56,500	445,000	7.88	40,134	637,062
1906	61,672	557,200	9.03	58,972	874,356
1907	67,800	626,000	9.23	72,010	905,047
1908	70,739	697,390	9.86	46,615	703,832
1909	48,536	359,957	7.42	81,802	862,002
1910	71,710	728,180	10.15	79,006	864,213
1911	62,030	613,286	9.89	81,521	1,032,732
Total	1,333,447	11,988,464	8.99	909,415	12,972,231

There are five producing companies, all operating in the region of Gouverneur, upon deposits associated with hornblende schists and crystalline limestone. The narrow talc belt is about 7 miles in length northeast and southwest, extending from the vicinity of Fowler to beyond Talcville.

The principal mines of the International Pulp Co. and of the United States Talc Co. are near Talcville. Their mills, except the Columbia, are located on the Oswegatchie River, which furnishes power. The branch railroad from Gouverneur to Edwards affords convenient transportation.

Next in order, to the southwest, is the Uniform Fibrous Talc Co., with its new mill, its mine and hydroelectric plant conveniently located with reference to the railroad. This company reported its first production in 1911. The Ontario Co., with mine and mill in the vicinity of Fullerville, on the South Fork of Oswegatchie River, not far from the middle of the belt, hauls its output by team to Gouverneur. The Arnold and Balmat mines of the Union Talc Co. are in the southwest portion of the belt and haul their output by teams to the mills of the International Pulp Co.

Only a small portion of this talc belt which is so conveniently located as to water power and transportation to market has been mined out, and it is destined to remain for many years much the largest source of talc in this country.

NORTH CAROLINA.

The output of North Carolina in 1911 was 3,548 short tons, 9 per cent less than in 1910. In value, however, the decrease was about 18 per cent, owing to the decline in output of the higher grades. North Carolina stands first among the States in the production of high-grade talc, such as is used for pencils, gas tips, and electric insulators. On the other hand, more than one-half of the output of the State is pyrophyllite, a silicate of alumina closely resembling talc and used for the same purposes. There were 6 producers, 3 in Moore County, 1 in Swain County, 1 in Alleghany County, and 1 in Jackson County.

PENNSYLVANIA.

The talc industry of Pennsylvania is limited to the eastern border of the State. The C. K. Williams and the J. A. Wagener companies have quarries and mills in the immediate vicinity of Easton, and the Atlas Mineral & Machine Co. is operating near Lafayette, on the Schuylkill, 6 miles northwest of Philadelphia. Owing to a less active market the production of 1911 was about 4 per cent less than in 1910. At Easton the material, though largely talc, is in part serpentine, which is locally designated as verdolite and is ground to make mineral pulp for a variety of uses. Some portions of the rock are massive, take a good polish, and are used for decorative marble.

VERMONT.

Vermont has been for many years the principal talc producer in New England, and ranks second in quantity of output in the United States, not only in its total production, but also in the production of both ground talc and soapstone.

There were seven producing companies in 1911, with a total marketed output of 29,488 tons, a gain of 14 per cent in quantity and 46 per cent in value as compared with that of 1910. By far the greater portion of the talc was ground; a small portion of it was sold rough as it came from the mine; and another portion, also relatively small, was manufactured into laundry tubs and other articles. Part of the waste soapstone from the factories was sold to grinding mills.

Two companies, the Union Soapstone Co., of Chester Depot, on the Rutland Railroad, and the Vermont Soapstone Co., of Perkinsville, on Black River, about 10 miles from the Rutland Railroad, have their own soapstone quarries and mills and have been in the business for many years.

There are four companies—the American Mineral Co., of Johnson; the Eastern Talc Co., of East Granville, Rochester, and Stockbridge; the American Soapstone Finish Co., of Chester Depot; and the Vermont Talc & Soapstone Co., of Windham—all of which produce ground talc. Although the mill in Windham has an advantageous location near the mine, the ground talc has to be hauled about 10 miles to the railroad. This plant, though comparatively new, is reported to have been improved, and the mine shows marked advance in quality and quantity of talc available.

VIRGINIA.

Virginia is by far the most important producer of soapstone in the United States. Although third in quantity of production, it ranks first in value of output, which in 1911 was worth $47,640 more than the talc production of New York and more than three times that of Vermont.

The production of the State was 26,759 short tons, valued at $660,926, an increase of 3.2 per cent in quantity and of 29 per cent in value as compared with the production of 1910. The quantities sold crude and ground were small, and 78 per cent was manufactured into laundry tubs and similar articles.

The various soapstone companies, known as the Old Dominion, the Virginia, the Climax, the Phoenix, and the Piedmont, all in the main soapstone belt in Albemarle and Nelson counties, were active during 1911, but no production was reported from the Tip Top, of Amelia County, nor from the Otter River, of Campbell County. In the northern portion of the State, in Fairfax County, only crude or ground talc was produced.

A new company, the Utica Mining & Milling Co., at Rhoadesville, in Orange County, reported a small production of soapstone of fine grade. It is said to be of quality sufficiently good to be used in the manufacture of gas tips and similar articles.

OTHER STATES.

California.—The California Talc & Soapstone Co., the only producer in California, with quarry 8 miles east of Lindsay, in Tulare County, reported a smaller production than in 1910.

Maryland.—The same thing is true of the Deland Mining & Milling Co., of Bald Friar, Cecil County, Md.

Rhode Island.—In Rhode Island one company is operating near Manville, in Providence County. The small production in 1911 was a decrease of 28 per cent from that of 1910.

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